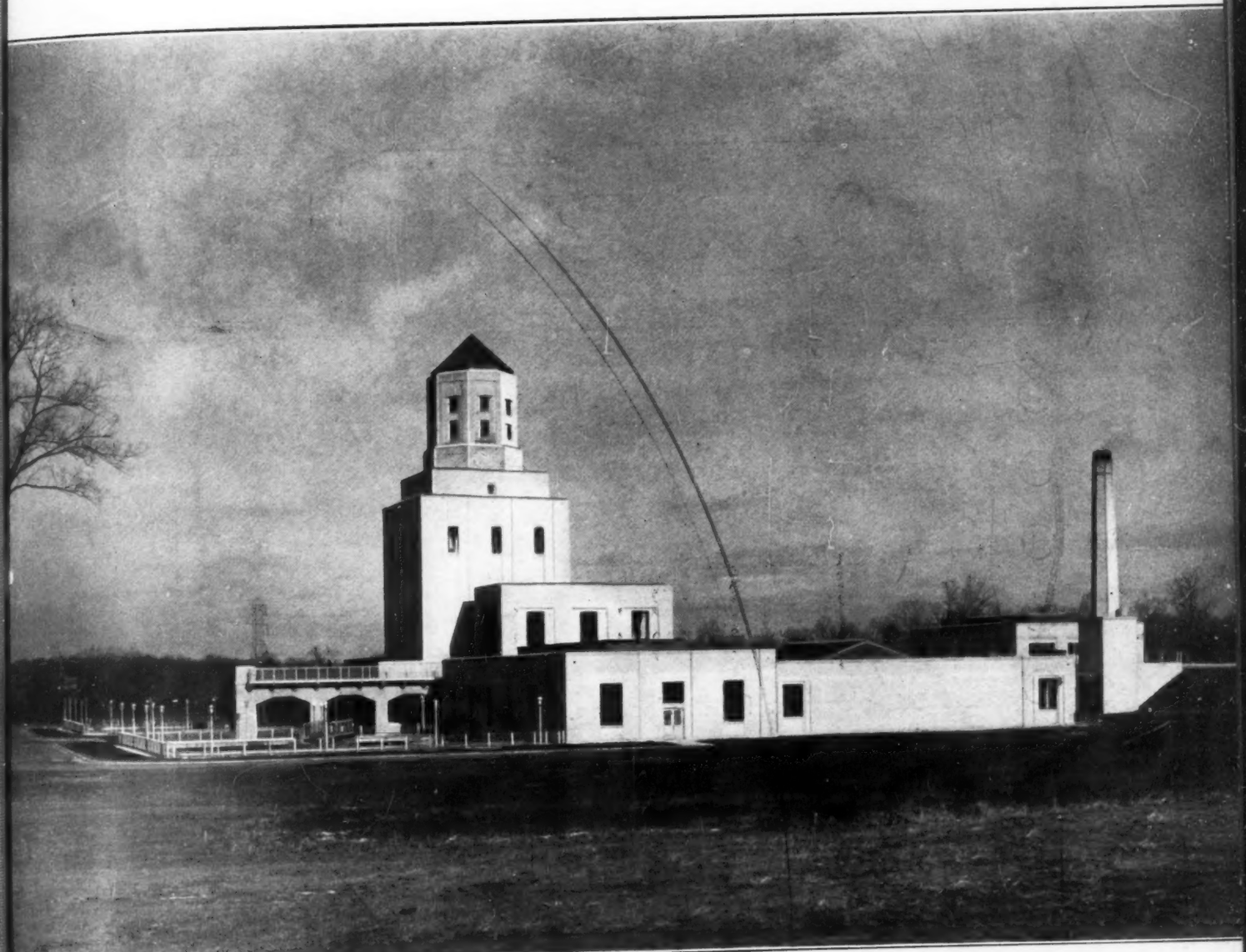
WATER WORKS AND SEWERAGE

January, 1934 — Vol. LXXXI. No. 1



Water Softening and Filtration Plant of the Mahoning Sanitary District, Niles, O.

A new product

FERRISUL

Ferric Sulphate

(Anhydrous)

by MERRIMAC

FOR WATER AND SEWAGE TREATMENT

- 1 Highest Ferric Iron content of any Iron Salt commercially available.
- 2 Readily soluble.
- 3 Low insoluble content.
- 4 Will not cake in storage.
- 5 Granular form for dry feeding.

Shipments are made promptly. May we quote on your requirements?

MERRIMAC CHEMICAL COMPANY

Everett Station, Boston, Mass.

A Division of

Monsanto Chemical Company

St. Louis, U.S.A.

DOING
One Thing
WELL
EBG
EBG
Liquid Chlorine
Look for the RED Cylinder
ELECTRO BLEACHING GAS CO.
Pioneer Manufacturer of Liquid Chlorine
Main Office: 9 East 41st Street, New York, N. Y.
Plant: Niagara Falls, N. Y.

AN ANSWER TO THE QUESTION:
"WHAT IS THE MEANING OF pH?"

pH *And Its* Practical Application

By *Frank L. LaMotte*
William R. Kenny
Allen B. Reed

Table of Contents

Section A. MECHANISM OF HYDROGEN ION DETERMINATIONS

I—Introduction and Preliminary Discussion
II—Hydrogen and Hydroxyl Ions
III—Buffer Action
IV—Determination of pH
V—Sources of Error

Section B. PRACTICAL APPLICATION OF HYDROGEN ION DETERMINATIONS IN INDUSTRY AND SCIENCE

VI—Municipal and Industrial Water Supply
VII—Water Corrosion Problems
VIII—Disposal of Sewage and Industrial Waste
IX—Sugar Industry
X—Gelatin and Glue
XI—Leather Manufacture
XII—Textile Industry
XIII—Pulp and Paper Industry
XIV—Food Industries
XV—Cleaning Processes
XVI—Electrodeposition of Metals
XVII—General Industrial Chemistry
XVIII—Bacteriology, Pathology, and Titration Procedures
XIX—Soils

$3.50

Cloth bound, 6x9, 255 Pages, Original Control Charts, Illustrated, Indexed.

The charts alone are well worth the price of this book.

TODAY the term "pH" is part of the routine vocabulary of almost every technical man, and the usefulness of the subject has benefited so many processes that it is now an accepted operating factor. So rapid has been its adoption throughout the technical world, that a great many routine workers now using some means of pH control do not have a clear understanding of the term "pH" itself, nor of the simple underlying principles involved in its measurement.

It is the purpose of this book to supply the need for such fundamental information in simple language, avoiding technical terms as much as possible.

Scientific men whose early training has not included this phase of chemistry and operating men will find "pH And Its Practical Application" to be a *practical* book for any reader who is not particularly interested in the theoretical aspects of hydrogen in concentration.

The broad scope of the book is indicated by the Table of Contents.

GILLETTE BOOK COMPANY

400 W. Madison Street
CHICAGO, ILLINOIS

------ **USE THIS COUPON** ----------

Name .....
Position .....
Company .....
Address .....
City ..... State .....

WW-1-34

GILLETTE BOOK COMPANY,
400 W. Madison St., Chicago, Ill.

I should like to have "pH And Its Practical Application" on 10 days' free trial At the end of that time I will remit $3.50 or return the book, postpaid.

WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

Harrison P. Eddy, Consulting Engineer of Boston and President Elect of the American Society of Civil Engineers, will contribute a review of "Progress in Sewage Treament During 1933" —to appear in the February issue.

C. P. Hoover, Superintendent of Water Purification, Columbus, O., will describe a new installation for "Unloading, Handling and Feeding Soda Ash" in water softening practice.

Darwin W. Townsend, Prin. Asst. Engr. Milwaukee Sewerage Commission, will contribute an article covering operating experiences and costs of centrifugal dewatering and incineration of screenings and grit at Milwaukee.

Chas. H. Capen, Consulting Engineer, East Orange, N. J., will tell of the results from ammonia-chlorine treatment of the Orange, N. J., water supply and some of the advantages and shortcomings of the process.

C. E. Keefer, Engineer in Charge of Sewage Treatment, Baltimore, Md., will tell of the beneficial results procured from sludge recirculation from bottom to top of digesters.

Frank C. Roe, Engineer of the Carborundum Company, Niagara Falls, N. Y., will describe the most satisfactory methods employed in cleaning and servicing air diffuser plates and tubes at sewage treatment plants.

L. C. Billings, Superintendent Filtration, Dallas, Texas, will relate his experiences with ferric iron coagulation involving the use of ferrous sulphate oxidized with chlorine—"chlorinated-copperas"—at Dallas.

S. T. Powell, Chemical Engineer, Baltimore, Md., writes on the "Corrosion of Water Well Casings by Electrolysis" and means of preventing such destruction.

Dr. F. E. Hale, Director of Laboratories, New York Department of Water Supply, will disclose the results of extensive tests on the permanency of cement linings in metallic pipes and means of preserving the life of such linings.

Horace A. Brown, Superintendent of Water Works, Ottumwa, Ia., will describe "The New Water Softening Plant of Ottumwa" which incorporates several novel features.

Philip Burgess, Consulting Engineer, Columbus, O., will describe a unique iron removal plant employing contact beds of anthracite coal operated at high rates.

Philip J. Martin, Superintendent of Water Works, Tucson, Ariz., will reveal methods employed in the "Control of Algae and B. Coli in Open Reservoirs" at Tucson.

Vol. LXXXI, No. 1

CONTENTS for JANUARY 1934

Progress in American Water Supply and Purification Practices During 1933 1
By H. E. JORDAN
Superintendent, Water Purification, Indianapolis Water Co., Indianapolis, Ind.

Unusual Features of the Lancaster, Pa., Sewage Treatment Works 7
By J. F. LABOON, C. E.
J. N. Chester Engineers, Pittsburgh, Pa.

Wayside Water Treatment on the Lehigh Valley Railroad..... 11
By J. V. CARDILLO
Water Inspector, Lehigh Valley Railroad, Sayre, Pa.

Report of Meeting of the Virginia Water and Sewage Works Association 15

Report of Meeting of North Carolina Section of the A. W. W. A. and North Carolina Sewage Works Association..... 19

The 20th Anniversary of the Completion of the Los Angeles Aqueduct 21

Cast Iron Pipe Used in Large Sewer Construction..... 23
By H. H. HENDON
Engineer in Charge of Sewerage and Sewage Treatment, Birmingham, Ala.

Reducing the Cost of Chlorinating..... 25
By C. H. VIVIAN

Methods for the Aeration of Sewage..... 27
By HAROLD E. BABBITT
Professor of Sanitary Engineering, University of Illinois

Tastes, Chlorine and Chloramines in Water Purification..... 31
By CHAS. H. CAPEN, JR.
Consulting Engineer, East Orange, N. J.

A Locking Device for Curb Boxes..... 34
By E. T. CROUCH
Manager-Superintendent, New Rochelle Water Co., New Rochelle, N. Y.

Editorials 35

Published monthly by the GILLETTE PUBLISHING CO., Daily News Building, Chicago, Ill.

Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under the Act of March 3, 1879. Published monthly at 400 W. Madison Street, Chicago, Ill Per copy 25c. Subscription rates $2.00 per year. Canadian and Foreign, $3.00 per year. Copyright, 1933, by Gillette Publishing Company, Publishers of: Water Works and Sewerage, Roads and Streets, Oil and Soap, The Art of Mosaics and Terrazzo, Road and Street Catalog and Data Book, Water Works Catalog and Data Book.

HALBERT P. GILLETTE, Pres. and Editor in Chief; E. S. GILLETTE, Vice-Pres. and Secretary; E. C. KELLY, Vice-President; J. M. ANGELL, Jr., Eastern Manager; L. H. ENSLOW, 420 Lexington Ave., New York, N. Y., Editor; C. T. MURRAY, Managing Editor; V. J. BROWN, Associate Editor; JOHN R. BAYLIS, Associate Editor; D. G. LEDGERWOOD, Make-Up Editor.

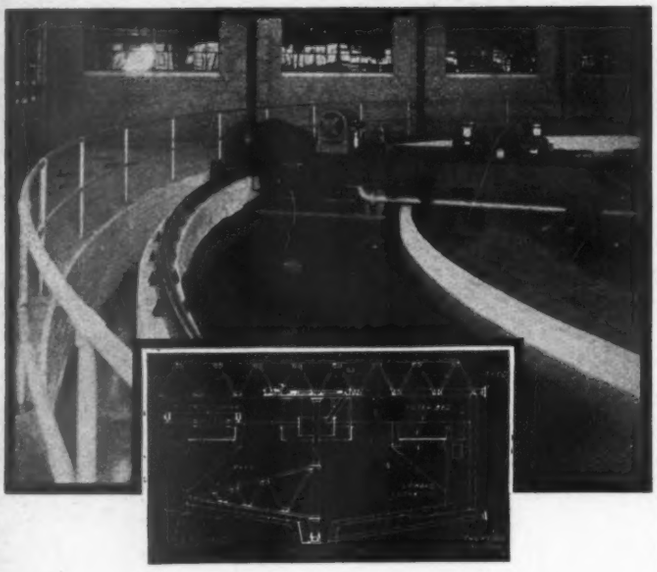
Chicago Office, Daily News Building. Cleveland Office, 2100 Keith Building. New York Office, 420 Lexington Avenue. San Francisco Office, 155 Montgomery Street.

Addresses will be changed as frequently as desired, upon notification; not otherwise. Changes of address should be sent in at least two weeks before the date of the next issue of *Water Works and Sewerage*, in order for them to be effective for that number. Immediate notice should be given of any delay in the receipt of the magazine.

FILTRATION EQUIPMENT CORPORATION

LAUGHLIN CLARIFYING TANK

For the Better Removal of Suspended Solids from Sewage and Industrial Wastes



—Permits of usual sedimentation and thickening operations within a tank, at high capacity for a given tank size.

—Removes solids by positive filtration.

—Filter bed embraces entire circumference of tank, extending inwardly five feet or more.

—Operated with a traveling magnet which cleans the filter bed as necessary.

—Tanks of round or rectangular type for any capacity.

—Low power and low operating cost.

FILTRATION EQUIPMENT CORPORATION
350 MADISON AVE. NEW YORK

Like an Elephant, the Public NEVER Forgets A BAD TASTING WATER

It has been said an elephant will starve before it will eat a food it has tried and did not like—humans are somewhat like that, too—they don't forget a Taste and Odor Epidemic.

The public's impressions are lasting—be sure the water you prepare and deliver to them is free from Tastes and Odors—the AQUA NUCHAR method of water treatment is insuring over 500 water works superintendents that the public's reaction to their drinking water will be favorable.

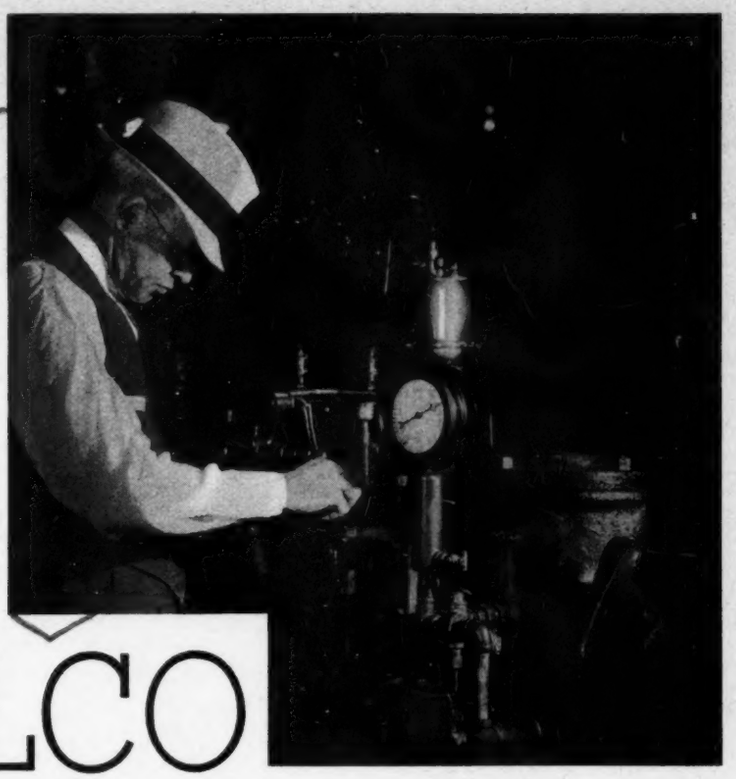
We are prepared to aid you in Taste and Odor Control.

WRITE for this booklet on the Method of Taste and Odor Control adopted by more than 500 cities—it also contains details on the latest procedures for determination of Tastes and Odors —WRITE FOR ONE.

INDUSTRIAL CHEMICAL SALES CO., INC.

New York, N. Y., 230 Park Avenue
Chicago, Ill., 205 W. Wacker Drive

POWDERED ACTIVATED AQUA NUCHAR AQUA PARKE



NALCO WAYSIDE TREATMENT

. . . economical and automatic

Nalco wayside plants are inexpensive . . . can be easily installed and as easily moved when necessary to consolidate water stations . . . are automatic . . . require little maintenance and attention.

Wayside treatment, as developed by Nalco in connection with its complete line of water treating chemicals, has made it possible to so extend the benefits of water treatment that practically all supplies can now be treated to advantage.

Nalco wayside treatment has produced marked economies for the railroads . . . *definite figures* that show a reduction in boiler work, lower fuel consumption and longer periods between locomotive shoppings.

Nalco wayside treatment has made possible—and economical—the treatment of billions of gallons of scale forming and corrosive water.

NATIONAL ALUMINATE CORPORATION

6216 West 66th Place **Chicago, Ill.**

The chemical proportioners used in the Nalco wayside treatment can be readily adjusted to vary the amount of sodium aluminate and other chemicals required. They are operated through a direct connection to the pump, by electric motor, by a Nalco water motor or through other means of control.

NALCO SYSTEM

MATERIALS · SURVEYS · LABORATORIES · SERVICE · EQUIPMENT · ORGANIZATION

THE DEVELOPMENT OF 1933

A NEW KIND OF FILTER ALUM

BLACKALUM

Patent Pending

STABILIZES SLUDGE—AIDS COAGULATION

BLACKALUM is a compounded filter alum scientifically prepared to aid coagulation and stabilize sludge—producing the effects of powdered carbon in coagulation processes. To demonstrate the advantages of Blackalum a short period of trial use **in the plant** is convincing.

BLACKALUM is offered as an improved coagulant, not as a taste and odor control material. For the latter purpose additional carbon is required.

BLACKALUM was developed by Water Works men, using powdered carbon for controlling tastes and odors. It checks putrefaction of sludge, "sweetens" filters, improves coagulation efficiencies—and frequently saves coagulant. Laboratory demonstrations are only partially convincing—a plant scale test is wholly so. Therefore, orders for small trial shipments are invited. **Each pound of BLACKALUM contains more than nine hundred billion particles of NUCHAR to serve as nuclei and be dispersed through the floc.**

Requests for samples and inquiries for details are invited.

ACTIVATED ALUM CORPORATION, 420 Lexington Ave., N. Y. C.

INFILCO PRODUCTS

Aerators
Automatic Boiler Blowdown
Basin Level Controllers
Chemical Proportioners
Clarifiers
Coagulant Feeders
Decolorizers
Depth Gauges
Directional Flow Controllers
Disk Filters
Dry Chemical Feeders
Filtration Plants
Filter Underdrains
Flow Indicators
Gravity Filters
Hot-Flow Water Softeners
Hydraulic Valve Controls
Hydrodaros Purifiers
Iron Removal Plants
Loss of Head Gauges
Lime-Soda Water Softeners
Lime Slakers and Feeders
Manometers
Orifice Feed Boxes
Oil Removal Filters
Proportioning Equipment
Pressure Filters
Recarbonating Equipment
Rate of Flow Controllers and Gauges
Sampling Tables
Solenoid Operated 4-Way Valves
Steam and Gas Purifiers
Strainers and Distributing Nozzles
Swimming Pool Filters and Equipment
Sterilizers
Taste and Odor Removal Plants
Thermal Tubes and Orifice Meters
Water Stills
Wet Chemical Feeders
Zeolite Water Softeners

In Step with Modern Methods

FIFTY years has seen the rapid sand filter plant pass through so many stages of refinement and elaboration it is difficult to realize that the modern water purification plant came from such humble beginnings.

But the reasons for this remarkable progress are not hard to find. The waterworks engineer has continually encouraged new equipment and new methods to further improve water quality—and has been willing to adopt improvements immediately upon their development.

International is proud of its reputation of being first to introduce and adopt improvements—first to discard features that have proven to be hindrances of progress. And by continued research and development International Water Purification Equipment will maintain its leadership year after year.

International Filter Co.
Water Softening and Filtration Plants
General Offices
326 East Van Buren Street, Chicago

INTERNATIONAL

"ISCO" Ferric Chloride

In the Filter Plant it is an effective and economical coagulant.

Ferric Chloride works fast—requires less mixing and settling time.

In the Sewage Plant it is an aid to rapid sludge drying. Applied to crude sewage it will increase settling tank efficiencies and reduce loadings on sprinkling filters and other secondary units.

Ferric Chloride treatment following sprinkling filters will produce a sparkling final effluent from humus tanks.

"ISCO" CHLORINATED LIME

For sterilization of water supplies or swimming pools, and for chlorination at sewage plants, provides a safe, convenient treatment with less total chlorine required.

"ISCO" SERVICE

We have a sanitary chemical engineering staff, experienced through wide contacts and successful installations. May they contribute their experience and information to your problem?

DISTRIBUTORS OF "CLIFF-CHAR" ACTIVATED CARBON

Write for full particulars

INNIS, SPEIDEN & CO.
INCORPORATED
117 LIBERTY STREET, NEW YORK.
Established 1816

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

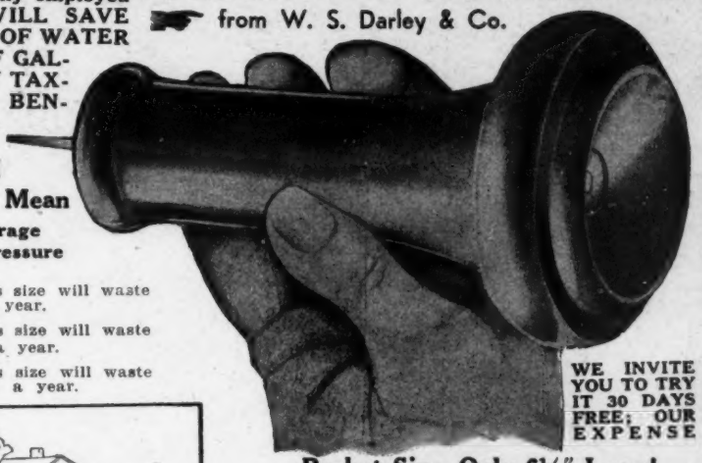
City of Chicago Water Department Co-operating with the NRA and CWA

More than 1,200 unemployed put to work with our Sonoscope, finding leaks in fixtures, services and mains.

Not only are the needy usefully employed but as a result Chicago WILL SAVE OVER 200,000,000 GALLONS OF WATER DAILY, or 73 BILLIONS OF GALLONS A YEAR and EVERY TAXPAYER WILL DIRECTLY BENEFIT.

ordered 1,192 of these Wonderful Leak Detectors

from W. S. Darley & Co.

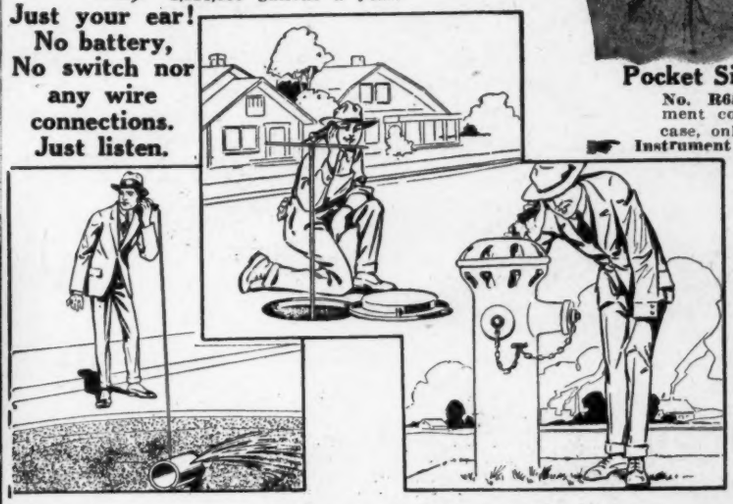


What Small Leaks Mean At Average Water Pressure

SIZE OF LEAK

- A leak this size will waste 62,000 gallons a year.
- A leak this size will waste 354,000 gallons a year.
- A leak this size will waste 1,314,000 gallons a year.

Just your ear! No battery, No switch nor any wire connections. Just listen.



WE INVITE YOU TO TRY IT 30 DAYS FREE; OUR EXPENSE

Pocket Size, Only 6½" Long!

No. R657. Sonoscope. This instrument complete, in a neat case, only **$3.70**

Instrument only (the case is not really needed), in dozen lots, each **$2.89**

In hundred lots we will quote a very special price.

TELEGRAPH US OUR EXPENSE

SEWER RODS THAT FLOAT!

In Stock, Ready for Shipment

One man can handle long runs easily.

Many jobs can be done with these good sewer rods that might, if left undone, cost many dollars to do later on.

The malleable connections are light and riveted with two flathead rivets, making a strong rod. Cannot come unhooked while in the tile because it requires they be held at nearly right angles to hook in or unhook. This is also an advantage while hooking together or unhooking, in taking them out. Order Champion Douglas Fir Rods for SERVICE and LONG LIFE and take advantage of the price. They should sell for more than Hickory rods but our price saves you 20% to 40%.

No. 510. Champion Sewer Rods. 3½ Feet Long. Each **55c**

No. 511. Champion Sewer Rods. 4 Feet Long. Each **65c**

CURB BOX CLEANERS

Because of the parallelogram action it is the ONLY cleaner that slides evenly parallel with the sides of the box and gets around broken brick, large stones, etc., and brings them up.

Well worth many times the price.

No. C746. New Curb Box Cleaner for boxes 3 in. diam. and smaller **$8.25**

No. C747. New Curb Box Cleaner for boxes 3 in. diam. and larger, including all gate valve boxes **$11.75**

Sewer Suits — Sewerage-Proof

Made of Olive drab double texture materials, with fine quality rubber joining the two fabrics.

Thoroughly waterproof, completely protected, most comfortable combination ever designed for cold, wet work.

No. 593. Sewer Suits. Each **$6.65**

Note: Regularly made in 3 sizes which correspond to 38, 44 and 48 inches breast measure respectively. Give size wanted when ordering.

EVERYTHING IN SEWER EQUIPMENT

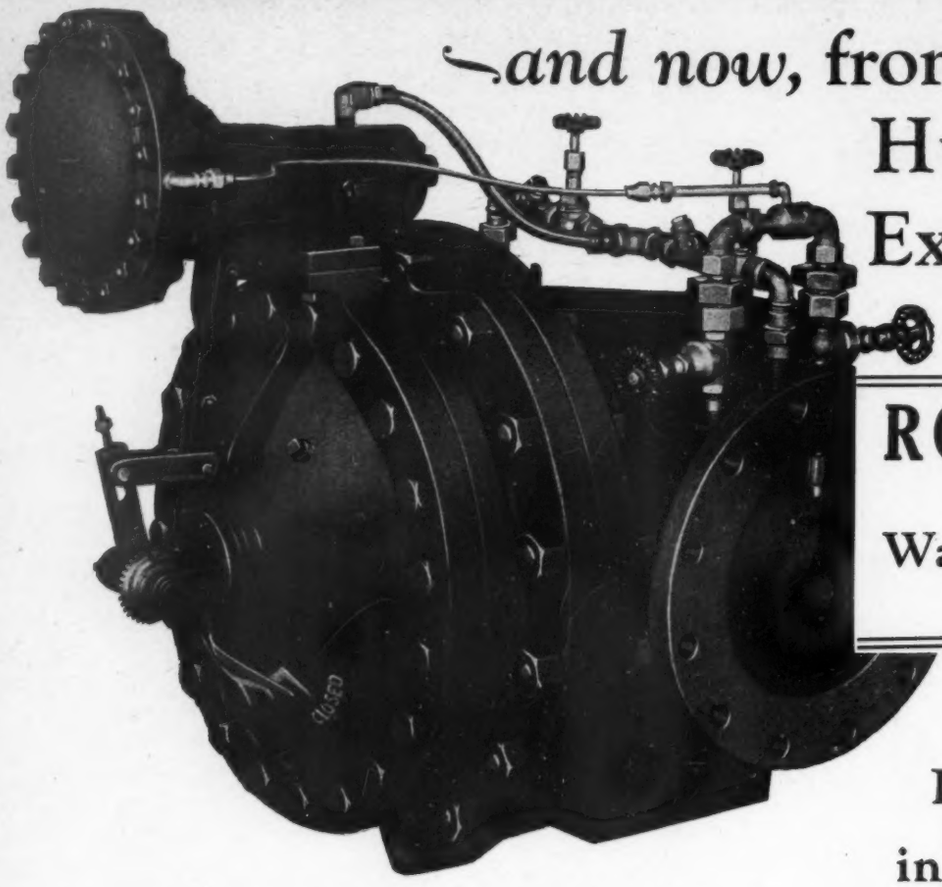
Sewer Cleaning Machines . Root Cutters . Flushing Hose . Flexible Steel Rods . Revolving Spear Points . Snake Cleaners . Bucket Scrapers . Manhole Jacks . Dippers and Sewer Spoons . Solvents . Electric Sewer Moles . Champion Sewer Rods and Attachments . Fishing Tools for broken or lost rods . Boots and Protective Clothing, etc.

WATERWORKS SUPPLIES

Pipe Locators . Magnetic Dipping Needles . Electric Leak Locators . Electric and Steam Pipe Thawing Outfits . Pumps . Leak Clamps . Split Sleeves . Calking Tools . Lead Melters . Hydrant Wrenches . Pipe Cutters . Service Cleaning Pumps . Meter Seals, etc., etc.

Write for Catalogs
World's Largest Makers of Municipal Supplies

W. S. DARLEY & Co., Chicago



...and now, from 55 Years' Hydraulic Experience ...we offer the

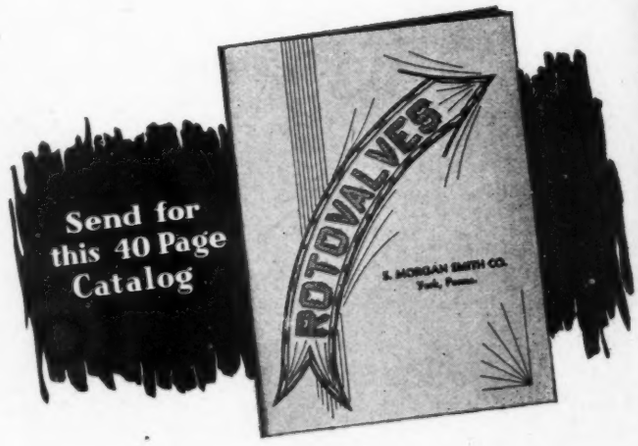
ROTOVALVE for Water and Sewage Uses

...as the Last Word in Mechanical Perfection and Design

Above: A Standard Automatic Check Type Hydraulic Operated Rotovalve, shown in closed position (horizontal assembly). Control valve may be controlled Hydraulically or Electrically. When Hydraulic Control is used, Check Valve opens automatically when the pump has built-up its head (against a closed valve) equal to head on line side. It closes automatically any time the pump stops. Control may be set so opening time of valve may be controlled independently of closing time.

This unusual Valve possesses many advantages, chief among which are: (a) Flush passageway throughout its length equal to full area of pipe connection (which reduces head losses to a minimum) (b) Tends to eliminate Surges and Water Hammers (c) 3-point bearings permit "exact" alignment of valve plug and body at all times and assure ease of operation (d) All valves re-seat in open position (e) All parts are interchangeable, etc.

ROTOVALVES are available for Manual, Electrical or Hydraulic Operation—in sizes from 6 inches to 48 inches inclusive—and for working pressures from 125 to 800 lbs. Flanged, Screwed and Hub-End Valves are standard.



S. MORGAN SMITH CO. HYDRAULIC TURBINES

Department S **York, Penna., U. S. A.**

Boston—Chicago—Salt Lake City—Denver—Portland, Ore.—San Francisco
(Associated Company—S. Morgan Smith—Inglis Co., Ltd., Toronto, Canada)

WATER WORKS AND SEWERAGE
VOL. 81 NO. 1 JAN. 1934
A GILLETTE PUBLICATION

PROGRESS IN AMERICAN WATER SUPPLY AND PURIFICATION PRACTICES DURING 1933

By H. E. JORDAN

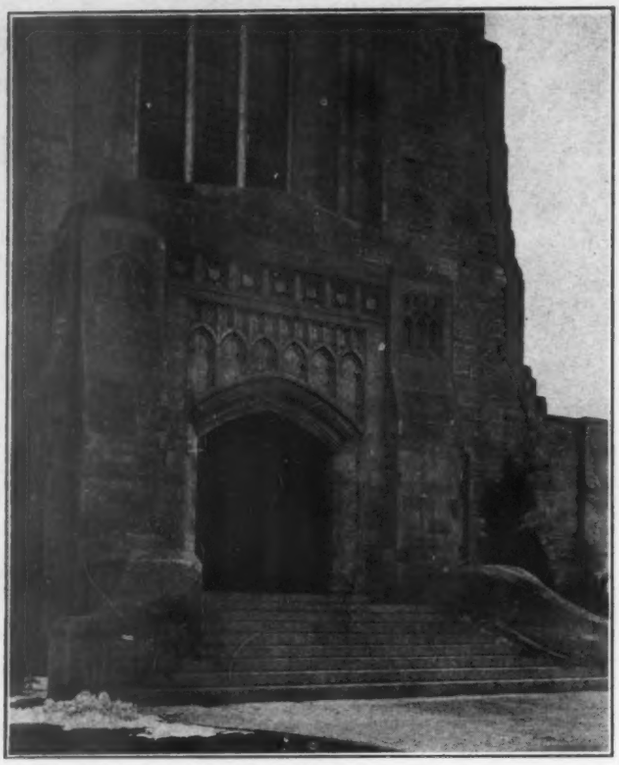
Superintendent Water Purification,
Indianapolis Water Co., Indianapolis, Ind.

THE brilliant editor of one of a group of nationally known newspapers recently asked a purification plant superintendent what he would do if bacteriological examinations indicated the water supply to be unsafe. The reply was: "Present day knowledge and operating efficiency are such that, barring a catastrophe of some sort, water purification is controlled, step by step, so that the operator of a modern system can be sure of the safety of the product as it leaves the plant."

H. E. Jordan

Such a reply is based upon these considerations: Conditioning of water prior to filtration, i.e., chemical treatment and sedimentation, delivers to filters a water in which the dispersed particles are brought together in aggregates which settle rapidly and adequately. If the pollution load is even a moderately heavy one, prechlorination is a regular part of the process and assures the delivery to the filters of a water from which most of the bacterial life has been removed. If the treatment processes involve lime softening, a routine of chemical tests has been established so that the treatment can be maintained within intended limits. The net result is to leave for the filters themselves, the second major step in routine water purification, a relatively light load well within their capacity to meet. The technic of filter sand conditioning and control has been materially advanced within recent years, and provided preconditioning of the water has been properly done, nothing but carelessness on the part of the plant personnel will preclude the production of a clear filter effluent. Sensitive turbidity observation units on the filters or on the main effluent lime will show at any moment, whether or not the clarification has been adequate. Finally, as has been often said before, chlorination is an integral part of the normal water purification process. Its control by means of a testing routine is so standardized that the historical record on any plant can be interpreted into a schedule for the proper titrable chlorine excess at a standard point after its application. This in turn assures conformance to bacteriological standards on the one hand, and on the other hand, a consuming public not displeased with the taste of the supply.

It is probable that quite a few persons in the water purification field will take issue with the apparently dogmatic attitude expressed in the above statements and claim that one or another legitimate deviation in operating routine might produce a state of irregularity in the bacterial content of the finished water. It would be well for all so disposed to examine carefully the triumvirate of required steps, before disputing the final conclusion. It is obvious that adequate water purification requires a proper balance between the various basic processes and not too much dependence upon any one—especially the last one. It is daring—if not bad judgment—to expect chlorination to cover up or correct all the previous in-



Main Entrance, New Pumping Station and Water Softening Plant, Fort Wayne, Ind.

adequacies of the treatment. Too often it may have successfully done so, but that only produces a sense of false security that had best be forgotten. Obviously again, inadequate preconditioning of the water may put too heavy a load on the filters, but adequate preconditioning is our job—not our alibi. Again, the filters may have succumbed to a too long continued inadequacy of pretreatment or of reconditioning and may fail to produce an effluent with not more than, say, 1.0 part per million turbidity. Such conditions, however, should lead not to complacency but to conquest. A combination of operating carelessness might produce a water inadequately pre-treated, settled and filtered and a turbid highly loaded filter effluent would be presented to the chlorinator for correction. The answer is, that the studies of Enslow, Wolman, Hale, Howard, Gerstein and many others have shown that given a reasonable task to do and time to do it, chlorination can be depended upon to complete a properly controlled purification process so that the final product can be confidently expected to conform to accepted bacteriological standards.

To control the various steps in the process a regular routine of manually handled tests can follow the water all the way from the intake to the point of delivery to the high service pumps. These tests can be made, at hourly or half hourly intervals by the shift men and can be made to cover every important factor in plant control. When, and if, the expense is justified, pH recorders, recording milliammeters (energized by photoelectric cells), recording conductivity units and automatice chlorine titration and recording equipment can be fit into the flow sheet. It is possible, thereby, to have chart records available to cover all of the important observations.

Surely there is no longer any reason, again barring catastrophe, why the purification superintendent should be in doubt as to the quality of the finished water from his plant.

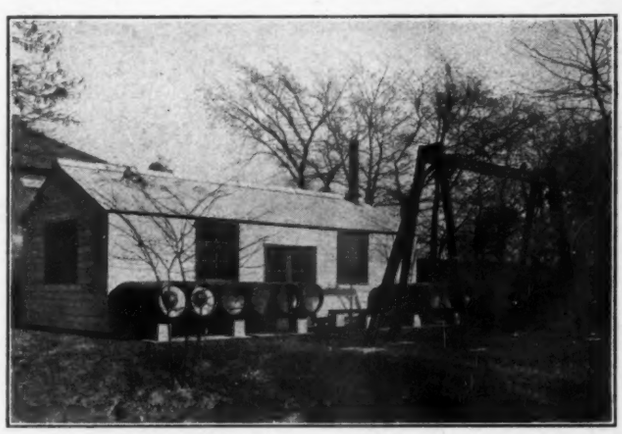
An Important Contribution of 1933

The year 1933 witnessed the completion of a very brief report, but one, intrinsically, as much a landmark in water purification practice as was the Louisville report of 1895 by George W. Fuller. "Public Health Reports" for April 14, 1933, contined the general summary and conclusions of a series of studies on water purification made under the direction of H. W. Streeter, Sanitary Engineer of the U. S. Public Health Service. Interim reports on phases of the investigation have been issued since 1927. The entire study is rounded up in a series of conclusions which in part are as follows:

"The relationships observed between raw or influent waters and effluent waters in respect to concurrent variations in their bacterial quality appear to be governed by a fundamental law, characteristic of all processes of water purification and simulating adsorption phenomena in its effects. The restrictions imposed by such a law on the efficiency of bacterial removal are such as to limit the average quality of effluent obtainable by a particular combination of treatment from a raw water of a given average degree of pollution and, conversely, the maximum pollution of a raw water from which an effluent of specified average quality can be produced."

"The efficiency of the ordinary more simple processes of water purification can be increased very measureably by means of certain modifications and elaborations in prefiltration treatment, notably by prechlorination, by longer periods of sedimentation, and by improved coagulation resulting from such measures as pH control and the more liberal dosage of coagulants. Similar results doubtless can be obtained by modifications and elaborations other than those included in these studies."

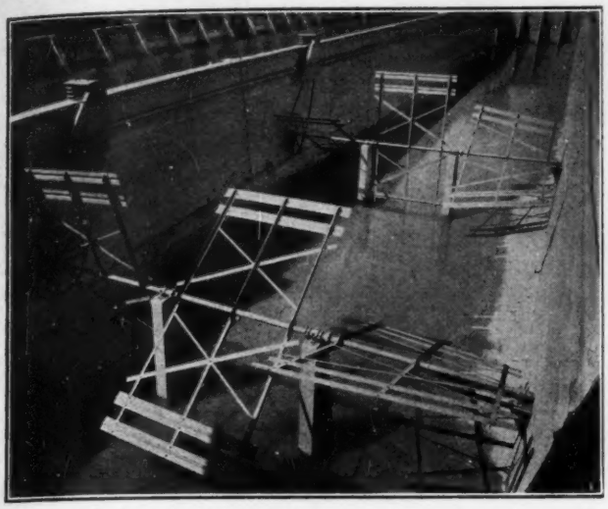
"The opportunities afforded during this investigation for observing the natural purification efficiency of prolonged storage of water prior to artificial treatment were very limited, but they were sufficient to point very clearly to the advantages inherent in this process, as a measure for effecting a preliminary improvement in the physical and the bacterial quality of highly polluted waters. The possibilities of this method, either through the construction of storage reservoirs or the impounding of water in flowing streams, have not thus far been fully utilized in this country, though they are widely recognized in certain European countries, notably in England, where storage is practiced extensively in connection with artificial water treatment. Although the difficulty and expense involved in providing long storage of water doubtless would be great in many instances, particularly in the level



Ton-Container Installation for Pre-Chlorination at the Plant of Indianapolis Water Co. Construction Consists of Welded Steel Frames with Asbestos Weatherboarding Shingles and Lining to Provide Fire Prevention and Easier Temperature Control.

sections of the middle west, its feasibility has been demonstrated even under such relatively unfavorable circumstances. It will be used more generally in the future than in the past, as its great advantages become more fully appreciated."

"It appears to be the opinion of some water purification specialists that virtually no limit exists as to the degree of raw water pollution which can be successfully



"Flocculators" Installed During the Year at the Louisville (Ky.) Filtration Plant.

dealt with by a sufficiently elaborated combination of water treatment processes now available. Particularly noteworthy is this sentiment among advocates of highly intensified methods of chlorination such as have been developed during recent years. Although such a result is theoretically possible and has been producible on an experimental scale, the practical difficulties standing in the way of its attainment in routine large scale water purification operations are well exemplified by the observations made, in the course of these studies, of the actual performance of 31 municipal water filtration plants, a large majority of which are required to handle raw waters of high and widely variable degrees of pollution. In no instance has conclusive evidence been afforded that these plants could produce effluents of satisfactory potability and sanitary quality from raw waters of unlimited degree of pollution."

"Finally, it may be noted that the restrictions which may be expected ultimately to govern the maximum permissible degree of pollution of sources of purified water supplies in the industrial areas of this country may prove to be conditioned more largely by the growing difficulties experienced in obtaining treated effluents of acceptable palatability and wholesomeness for domestic use than by considerations affecting merely the bacterial quality of such effluents. In this connection, the possible relation of water borne outbreaks of gastro-intestinal disturbances to the presence of chemically or biologically toxic substances in purified water supplies, derived from sources highly polluted by sewage and certain kinds of industrial wastes, cannot be wholly discarded, in view of the history of such outbreaks during the recent period of drought. Although the prevalence of urban typhoid fever has been reduced to a point such that it is now a minor cause of death, the occurrence of 242 water borne outbreaks of this disease in the United States during the decade 1920-29, as recorded recently by Wolman and Gorman, indicates that it has not been eliminated as a definite hazard. As 49 of the outbreaks thus recorded were due to failures of water treatment, it is evident that the mere existence of purification facilities has not conferred immunity from this disease."

"Future developments in the reinforcement of water purification systems which may have to deal with raw waters taken from excessively polluted sources probably will tend to follow present lines, notably in the direction of intensified chlorination and the further elaboration and improvement of preliminary treatment of water. Storage, both natural and artificial, will assume a role of increasing importance in these developments. Treatment of sewage and of certain kinds of industrial wastes likewise will receive more attention as special measures of protection for sources of water supply."

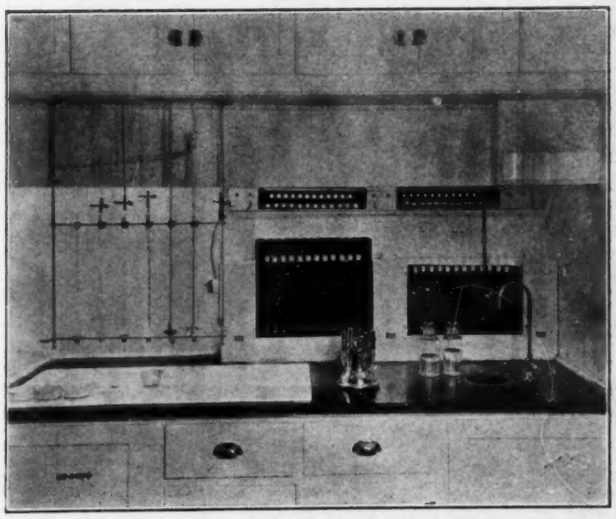
"The weaker links of water purification should receive more attention, as they doubtless hold the key to many of those lapses and variations in efficiency which thus far remain unexplained."

One tabulation in the report merits repetition. It summarizes the bacterial removal by various stages of the process in 3 types of plants: A—The experimental plant of the U.S.P.H.S. at Cincinnati; B—A group of municipal filtration plants along the Ohio River; C—A group of municipal filtration plants along the Great Lakes.

TABLE 1.—RAW WATER BACTERIA REMOVED BY EACH STAGE OF TREATMENT

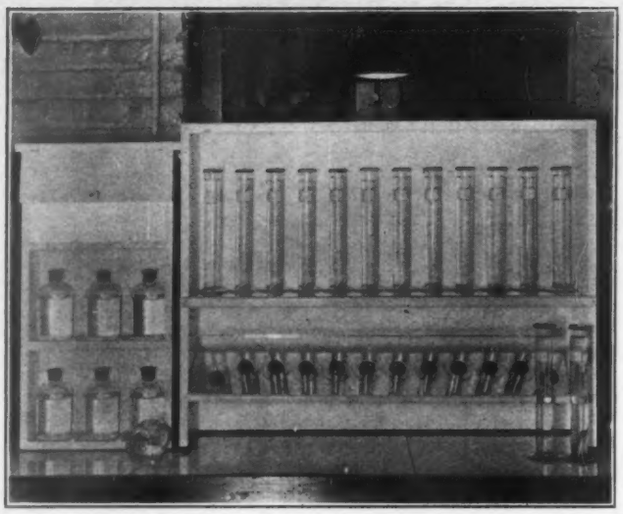
Stage of Treatment	Percentage of total raw water bacteria removed 24 Hrs., 37° C. plate count			B. Coli Index		
	Series A	Series B	Series C	Series A	Series B	Series C
Coagulation-sedimentation.	72.9	82.6	59.0	60.1	77.5	62.7
Filtration	25.9	16.6	27.2	39.78	22.42	32.50
Postchlorination.	1.14	.68	12.36	.10	.07	4.24
Combined	99.94	99.88	98.56	99.98	99.99	99.44

The data in Table 1 emphasize a feature in normal water purification operations likely to be overlooked,



Titration Assembly and Comparator Rack for Residual Chlorine, Indianapolis Water Co. Laboratories. Comparisons Are Made by Viewing the Colors (White Spots in the Photograph) Reflected to the Eye of the Observer by the Inclined Mirrors Shown Above the Tubes. Indirect Lighting Is Used in the Titration and Colorimetric Work.

namely that the coagulation-sedimentation phases of modern water purification are of dominant importance. In the light of these data one cannot emphasize too strongly the importance of continuous and careful control of the "conditioning-for-filtration" phase of water treatment. A review of the advances made since the Fuller-Louisville study evidences the fact that few changes have been made in technic of operation of filter



Turbidity and Residual Chlorine Testing Equipment Provided for Use of Shift Men at the Indianapolis Water Co. Plant. Colors Are Matched by Looking at the Reflected Images in the Inclined Mirror Below the Rack. The Equipment Is Located at a Convenient Point in the Filtration Plant, Artificial Lighting Being Used at All Times to Secure Uniform Conditions.

units themselves, but in the conditioning phase, a variety of coagulants have become available, the function of pH control is fairly well understood, a variety of mixing devices are used and recently the "flocculator" development by Smith at Richmond, and adopted at other points, has added materially to the efficiency of pre-treatment. Morril's studies at Detroit have also shown clearly the value of careful control of flow—both at the inlet and outlet points as well as in the basins themselves.

New Plants of 1933

Two fine additions to the list of operating water softening plants have been made during 1933, viz.: that of the Mahoning Valley District located at Niles, Ohio,* and that at Fort Wayne, Ind. In Canada, the 40 m.g.d. filtration plant at Hamilton, Ont., went into service. Again the changes in pre-conditioning are striking. It will be remembered that, after a very thorough experimental study had been made, the Columbus (Ohio) plant, completed in 1908, was built with settling basins having a rated retention time of 12 hours. Settling basins at Fort Wayne are rated at 5½ hours' retention whereas at the Mahoning Valley plant the retention period rating is only 2 hours. Such changes in conditioning time afford a material economy in plant construction costs but, naturally, the control of operating routine must be of highest quality if mishaps are to be avoided. Physical facilities have been provided by the designers at the Mahoning Valley plant by locating a control and chemical testing table between the head house and the mixing chambers for facilitating the control work of the operators. Such treatment of plant design serves as an example of the ease with which control determinations can be put into the hands of men on operating shift duty. Naturally a higher caliber individual is needed for this type of work than the type one sometimes finds in filter plants. With the time element so materially shortened, the efficiency of manual control might be very wisely double checked by the use of recording pH or similar equipment.

The changes which have gone on in water softening since the completion of the Columbus plant are to a large degree the result of the intelligent research by Chas. P. Hoover, who has been Chemist in Charge of the Columbus plant for many years. The practical demonstrations of the value of excess lime treatment, clarification and recarbonation at Columbus and elsewhere have been a major contribution by Hoover to the advances in municipal water softening.

In Ohio, among quite a few plants built in recent years, one is struck by the extraordinarily fine quality of the supply of the little city of Findlay, where half of the product of a lime softening plant is passed through zeolite filters and the mixture of lime softened and zeolite softened water delivered to the consumers. Such elaboration of treatment and the active approbation of such a supply by its users should be carefully considered by those who are reluctant even to filter a city's water supply.

Improved Appearances of Modern Plants

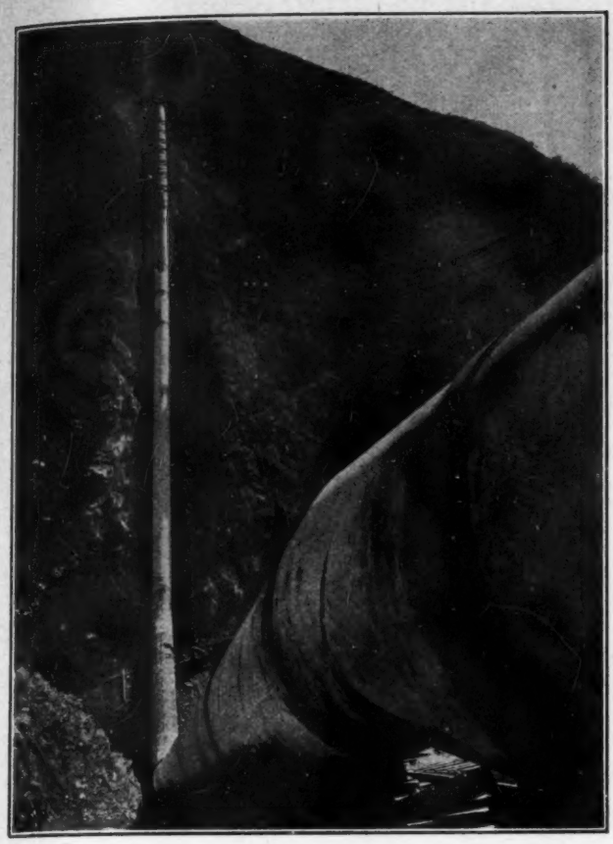
In the same vein, one is amazed at the advances in purification plant architecture. From the "not-so-good" old days of wooden tub filters and lean-to type of building the beauty of water plants has grown to the type of the Fort Wayne, Erie, Springwells (Detroit), Mahoning Valley, Easton, Findlay, Saginaw and many other plants, where plants, functionally adequate, are in addition placed in an architectural framework both durable and beautiful. One cannot doubt for a moment that the Fort Wayne citizen will view with satisfaction and proudly show visitors the local water plant with its magnificent setting and its architectural harmony. And as he and the visitor enter the building through the beautiful main doorway, a picture of which accompanies this article, both are far more likely to hold in respect the water supplied by the plant, than would be the case if it were an ugly pile of disharmonious units. If we consider such architecturally satisfying structures in no other light than as monument to those whose lives have been made longer by safe water supplies, the idea is worth while. But when the aggressive loyalty of a community is built up by a plant of which it can be proud, what reason is there to perpetrate an eyesore?

Reawakening of Interest in Iron Salts as Coagulants

The use of iron salts in water treatment is now actively rejuvenated. Thirty years ago Bull used ferrous sulfate and lime at Quincy, Ill. The combination of materials was used for a time in quite a few plants in the middle west. St. Louis and Cincinnati continue to use it. But it was not until 1927 that Enslow and Hedgepeth successfully chlorinated ferrous sulfate and

Entrance Lobby, Fort Wayne's New Softening-Filtration Plant. In the Center the Visitor Observes the Filtered Water in the Illuminated Clear-Well.

*See front cover illustration.



New Aqueduct to Serve Los Angeles Under Construction—Size 6 ft. 8 in. to 7 ft. 10 in., with Wall Thickness of 1-1/16 in. to Withstand Pressure of 400 lbs. per sq. in. in Rough Country. The 12-ton Sections Are Joined by Electric Welding.

applied it in the treatment of a highly colored soft water at Elizabeth, N. C. Several other plants along the Eastern seaboard have found this type of coagulant effective. Unpublished data from Billings at Dallas indicate its value in treating that supply which is not soft nor highly colored and which is frequently quite turbid. Following the 1930 drought, extremely high color complexes at Elizabeth City were broken down first by the addition of lime to bring the pH up to 8.8-9.8 followed in turn by permanganate of potash, chlorinated copperas and alum. The treatment resulted in a filter effluent having an iron content ranging from 0.2 to 1.0 p.p.m. and a negligible color. At Providence, the need for manganese removal led first to the use of chlorinated-copperas and later to the use of lime to bring the pH up to 9.6 followed by the recently available "Ferrisul"—a ferric-sulfate coagulant. A series of studies under Bartow's direction included the study of ferric coagulants. The material is too extensive to summarize here but reference to the published reports should be made by all persons interested in coagulation experiments.

During the year a new alum (Block-alum) coagulant has appeared. It is a compounded sulphate of alumina containing powdered activated carbon.

Progress With Taste and Odor Control Measures

The use of various taste-odor improving materials such as ammonia or activated carbon is extending. Not so many data are published because much of the spade work has been done and now the operators are tuning up the operations and cutting down the dosage. Carbon, for example, is applied by Smith at Richmond only as a batch to a filter unit just after it has been washed. Jordan at Indianapolis, has applied it also to settled water flowing to *slow* sand filters at rates up to 1.2 p.p.m. with no adverse effect upon the productivity of the unit but with a very material benefit to the taste of the effluent as well as to the condition of the filter sand. It is now evident that carbon as a routine water treatment material affords improvement in water supply taste conditions, when applied at a much smaller dosage rate than was first felt necessary, if the material be applied at the strategic point in the purification process. The improvements in carbon application, as pointed out by Enslow in a yet unpublished paper, read before the New England Water Works Association, make it possible to transfer the ammonia treatment, when useful, to a point where its function is the prevention of chlorinous tastes and the maintenance of a chlorine residual well into the distribution system. This again is an economy, if prechlorination is practiced, for, if the ammonia is applied so as to be effective on the effluent only, the quantity used needs to relate only to the effluent chlorine. It appears likely that the ammonia-chlorine combination, in effluent treatment, can be used to prevent distribution system problems associated with dead ends. The putrefaction and resultant "black" water, containing hydrogen sulfide, may be preventable by closer attention to long term residuals produced by the post ammoniation-chlorination.

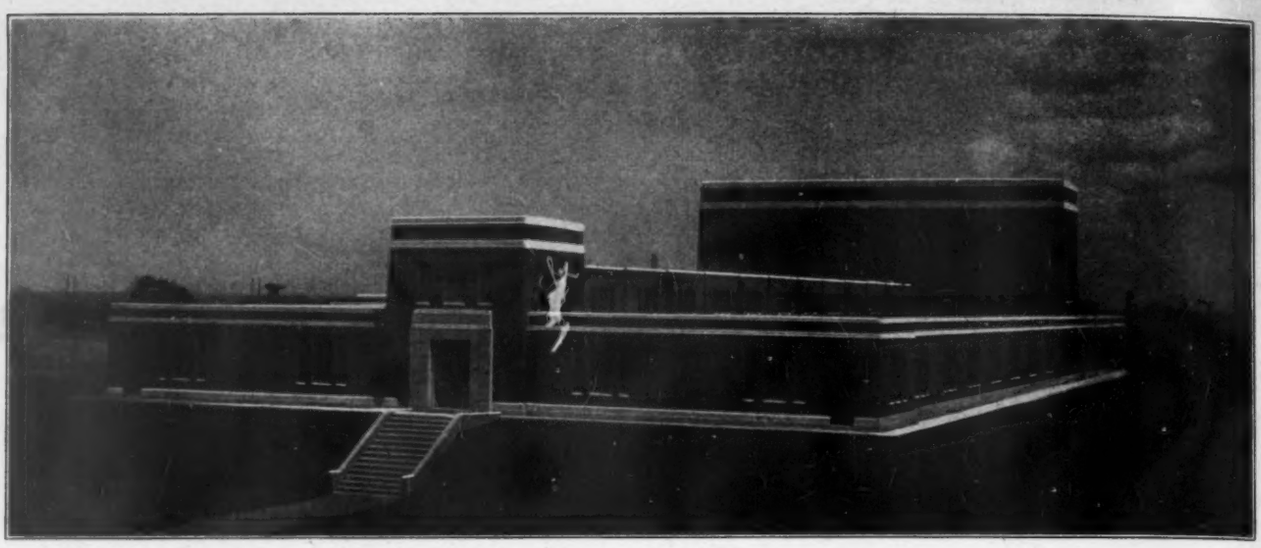
Improved and Economical Handling of Chlorine

The installation of ton container handling equipment for chlorine is growing. Detroit, Richmond, Washington, Cleveland and Indianapolis, among others, have completed installations and those for Atlanta and Chicago are in process. The differential between net chlorine costs when purchased in 150-lb. vs. 2,000-lb. containers is such that if more than 60,000 lbs. of chlorine is used on any plant in a year's time, the economy may be used to amortize the plant cost in a few years and the lessened cylinder handling problem on the plant pleases the attendants greatly. The Chicago installation is planned for the intakes on the south side which have been so frequently adversely affected by industrial pollution from the southern end of Lake Michigan. It will be combined with an ammonium sulfate feeding plant.

Laboratory Improvements Need More Attention

Along with the advances made in the general architecture of water plants, it is not apparent that the

Mixing and Reaction Tanks Mahoning Valley Softening Plant—Sixteen Impeller Agitators in 20 ft. Diameter Tanks. (See Front Cover for Picture of the Plant.)



New 30 M.C.D. Filter Plant at Hamilton, Ont.

laboratories have similarly improved. The arrangements and equipment details of some laboratories in the newer plants are good, in others bad. The fault may lie with the laboratory men for expressing themselves freely upon plant control details but accepting anything which goes under the name of a laboratory for the heart of their activities. To begin with, no new plant should include a bacteriological laboratory which assembles a motley array of separate media storage compartments and incubators. For more than 10 years, examples have been available of assemblies of cold storage, low temperature and high temperature incubating equipment, built as a continuous series of well insulated units into the laboratory building structure. They are easily operated, easily maintained and pleasing to the eye. Again plant designers have had a mania for light in laboratories, even to the extent of forgetting that the only useful daylight in the northern hemisphere—from a technical standpoint—is north light. Yet there are chemists in new plants who are compelled to carry on work exposed to the full effect of a summer afternoon's sun. As a matter of fact, under modern electric current conditions, routine titrations and such tests as that for residual chlorine are much better carried on—not in front of a window, but away from a window—with artificial light of the various color qualities now available. This is exemplified by the assembly employed at the Indianapolis laboratory (see illustration). At the left of the picture, burettes are shown. These are filled by gravity flow from stock bottles in the dark cabinet above. Back of the opaque panel at the top of the burettes are a series of lamps, daylight type for routine titrations, and yellow light for chloride titration. At the right, in the rear are two sets of comparison tubes, one for color and the other for residual chlorine determinations. Light from below travels up through the Nessler tube, strikes the tilted mirror above the tube and is reflected to the eye of the chemist. The Nessler tubes are topped, not with a cork, but by a glass cover slip held in place by paraffin. Evaporation and dust collection are eliminated, replacement of standard solutions is simple. Underlying all this is the fact that on bright days or cloudy, at noon or at midnight the lighting conditions are basically the same.

A similar type of assembly, also illustrated, has been provided for shift operators to use in making their hourly tests on effluent chlorine and filter influent turbidity. Again electric lamps furnish the illumination on the left for a turbidity unit of the Weir (Atlanta) type and on the right for an O-T color comparison outfit. The color standards for the latter are set up in a series of footed hydrometer jars, containing the depth of standard as specified in Standard Methods of Water Analysis and covered by a disc of "crystal sheet" glass sealed on with wax. The same type of jar is used for the sample which, incidentally, is kept in the dark for the period of color development.

Many more observations concerning laboratory equipment and construction might be made. Let these suffice if they will bring to the minds of the consultants and designers the fact that there are many modern products that may be used in laboratory construction and equipment as well as in the rest of the plant.

Just at the moment, the effect of the alloting Federal funds to be used in water works improvements has been to start the construction of quite a few filter plants. Very few were completed in 1933 for even under R.F.C. funds availability, the deflationary effect of tax reduction crusades postponed many needed water works improvements. At the beginning of 1934 water purification men, as well as all other classes and professions, are hopefully looking forward to a year less full of fear and more replete in new developments than was 1933.

▼

Association Meetings Scheduled

Jan. 15-17—Texas Water Works Short School. Baker Hotel, Dallas, Tex. Secretary, V. M. Ehlers, Chief Engineer, State Department of Health, Dallas, Texas.

Jan. 16—New York State Sewage Works Association. Hotel McAlpin, New York City. Secretary, A. S. Bedell, State Department of Health, Albany, New York.

Jan. 17-19—American Society Civil Engineers. Headquarters, Society Building, New York City. Secretary, Geo. T. Seabury, 33 West 39th Street, New York City.

March (1934)—Kentucky-Tennessee Section A.W.W.A. Knoxville, Tenn. Secretary, F. C. Dugan, State Department of Health, Louisville, Ky. (Exact date later.)

April 4-6—Canadian Section A.W.W.A. Hotel Royal York, Toronto, Ont., Canada. Secretary, A. E. Berry, Ontario Department of Health, Toronto, Ont.

April (1934)—Southwestern Section A.W.W.A. Partridge Inn, Augusta, Ga. Secretary, W. H. Weir, State Board of Health, Atlanta, Ga. (Exact date later.)

June 4-8—Annual Convention of American Water Works Association. Hotel Commodore, New York City. Secretary, B. C. Little, 29 West 39th St., New York City.

Aug. 23-24—Central States Section A.W.W.A. Hotel Windsor, Wheeling, W. Va. Secretary, H. L. Nelson, U. S. Pipe and Foundry Co., 2435 Koppers Bldg., Pittsburgh, Pa.

UNUSUAL FEATURES OF THE LANCASTER, PA. SEWAGE TREATMENT WORKS

By J. F. LABOON, C. E.

J. N. Chester Engrs., Pittsburgh, Pa.

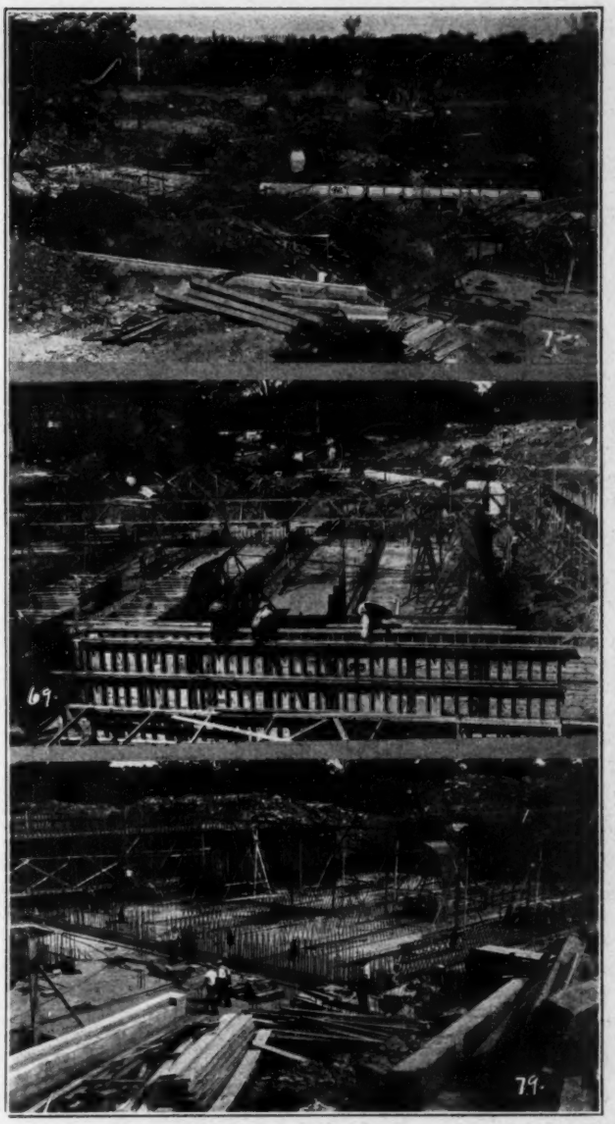
J. F. Laboon

THE citizens of the city of Lancaster, Pa., under its present administration, had the courage and conviction to vote a bond issue in the sum of $3,250,000 on March 17, 1931, by a majority of three to one for the purpose of revamping the sewerage and water systems of the city. Amongst many other items, two sewage treatment plants of the activated sludge type, each with a capacity of six million gallons daily, are being built—this, in the face of the depression which already was being felt quite severely in this community, as well as elsewhere throughout the United States. The amount of the bond issue was determined from a comprehensive report made by The J. N. Chester Engineers and presented by them on December 10, 1930.

The city of Lancaster, for almost two centuries, has limited the area of the city to four square miles, thus building up a dense population which in recent years has spread out to the territory beyond the city limits and resulted in a goodly sized community living outside the city bounds. The survey of the consulting engineers covered the entire watershed development of the city of Lancaster and vicinity for ultimate development of sewerage facilities, while the studies for the Water Department extended even beyond the drainage bounds. Up to this time the city had no reliable sewer map showing correlated data of its sewerage system, and this necessitated a complete survey of the sewerage system of Lancaster in order that a sewer map could be drawn showing sizes and grades of sewers in order that capacities of each sewer could be calculated. Continuous weirings were made of the main outfalls at Clay Street, Water Street and Stevens Avenue and composite samples of sewage were collected and analyzed.

The report included a sanitary survey of Conestoga Creek along its course through the city and for a distance of 17 miles down stream for the purpose of determining the true conditions of the stream and its ability to assimilate the tremendous load which was being imposed upon it in the nature of raw sewage discharged from the several outlets. This survey developed that, with a dissolved oxygen content of 9.2 p.p.m. in the creek waters above the Clay Street sewer, the stream 5.4 miles below the Water Street sewer (a distance of 12 miles below the Clay Street sewer) had a dissolved oxygen content of 11.2 p.p.m., notwithstanding the fact that the entire sewage of the city of Lancaster had been discharged into the stream in an untreated condition. At no time was the sewage of the city found to be septic at the outfalls, dissolved oxygen being present in every sample taken. Conestoga Creek has an average fall of about 2 ft. per mile throughout the length of stream surveyed.

As a result of facts revealed by the stream study, it was felt that secondary treatment of sewage from the Water Street outfall at the southern limits of the city could be dispensed with, inasmuch as complete treatment would be given to all sewage entering the stream above this point, thus cleaning up the stream within the city limits where it would be used for recreational purposes. With such a reduction in the load placed upon the stream, the stream below the city would be in a much improved condition as compared to its present state, even with

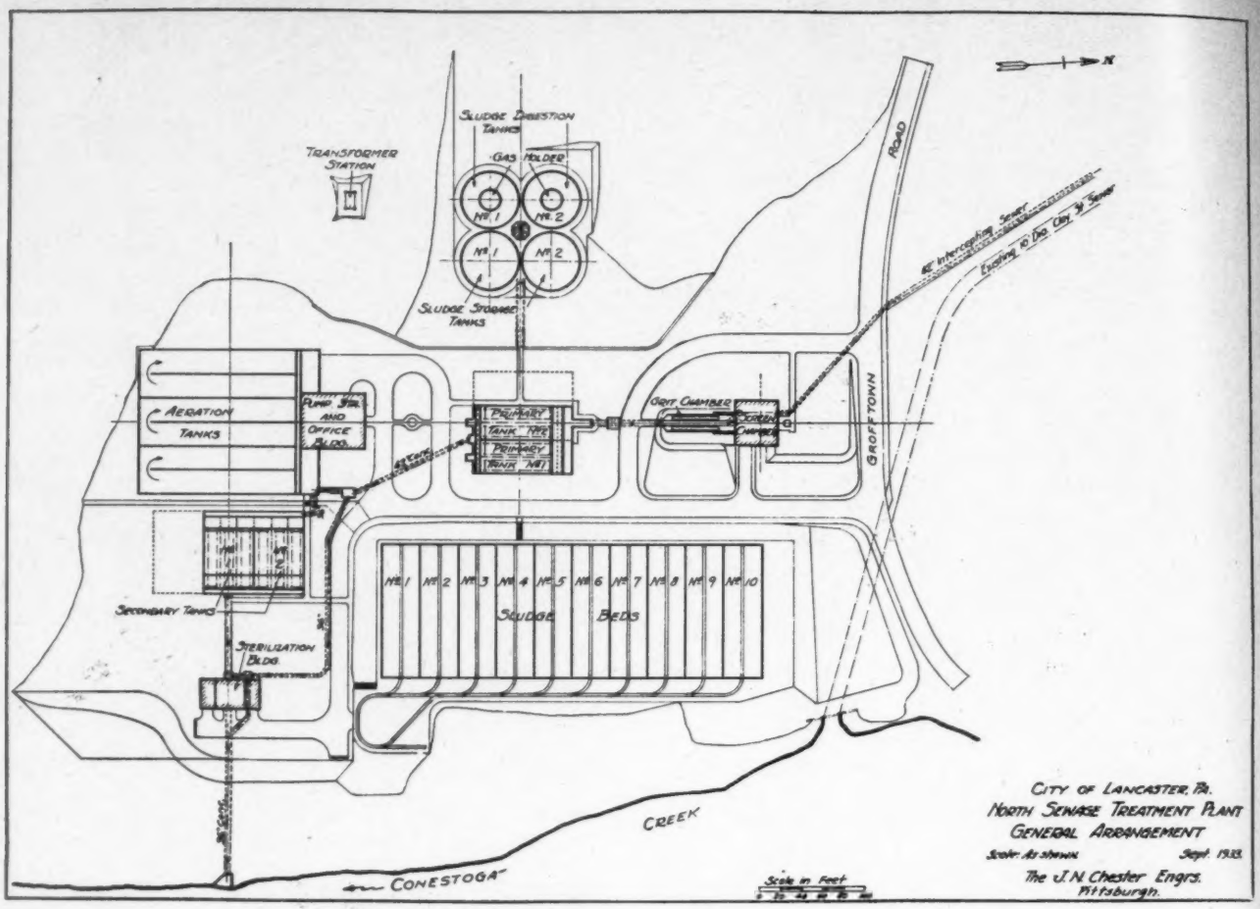


Construction Views of the Lancaster, Pa., Sewage Treatment Plant. (See Plan Showing General Arrangement of Plant.)

Upper: (Looking East)—Primary Tanks on Left; 42 In. Concrete Sewer in Center Is Between Primary Tanks and Control Chamber; Main Building Foundation in Right Foreground, Sludge Beds in Center Background.

Middle: (Looking North)—Aeration Tanks in Foreground; Main Building and Head House Just Beyond; Primary Tanks in Center Background.

Lower: (Looking Southeast)—Head House in Left Fore-Ground; Aeration Tanks Center; Secondary Tanks in Upper Left Ground.



The North Sewage Treatment Plant Under Construction at Lancaster, Pa.

secondary treatment eliminated from the South Sewage Treatment Works. After a full discussion of the problem, the authorities decided it preferable to provide complete treatment for the whole of Lancaster's sewage.

Sewage Treatment Works

The unfavorable topography of the city and the unavailability of suitable sites made it impractical to collect and treat all of the sewage at a single plant. It became necessary, therefore, to design two sewage treatment plants, one plant being located in the northeast section of the city and known as the North Sewage Treatment Works and the other south of the city along Conestoga Creek, known as the South Sewage Treatment Works. Each plant has been designed for a normal capacity of 6 M.G.D. to employ the activated sludge process. Although fixed charges and operating expenses are higher with this type of treatment works than any other considered, certain advantages such as reduced first cost, high degree of purification and reduced odor and fly nuisances were among some of the points taken into consideration.

The sewage treatment works were designed for 1945 conditions, when it is expected that a population of 29,000 will be connected to the North Sewage Treatment Works and 54,500 to the South Plant. Each plant is arranged so as to permit of convenient extension for treatment of sewage from a combined ultimate population of 110,000 anticipated in the year 1970.

The weirings developed the flow in November, 1930, to be 3.25 M.G.D. for a six day average from the Clay Street sewer; 3.61 M.G.D. for a seven day average from the Water Street sewer; 194,000 G. P. D. for a six day average from the Stevens Avenue sewer; and the Susquehanna Street Sewer is estimated to flow at the average of 50,000 G.P.D.

Both the north and south sewage treatment works are exactly alike, as regards capacities of main units and structures, except that the South Plant includes a sewage pumping station and appurtenances located in the aeration pipe gallery. Although the population served by the South Sewage Treatment Works will be almost double that served by the North Sewage Treatment Works, the suspended solids in the sewage reaching the South Plant will be about 15 per cent less than that received at the North Plant. The volume of sewage contributed to each plant for the present will, however, be almost equal. The biochemical oxygen demand of the sewage discharged from the Water Street sewer is somewhat greater than that of the Clay Street sewer due to the small packing houses and other establishments contributing trade wastes to the Water Street sewer.

The North Sewage Treatment Works were designed on the basis of a sewage having the following characteristics:

	p.p.m.
Suspended Solids	150
Organic Nitrogen and Free Ammonia	34
20 Day B.O.D. (Equivalent)	200

The South Sewage Treatment Works were designed on the basis of:

	p.p.m.
Suspended Solids	125
Organic Nitrogen and Free Ammonia	39
20 Day B.O.D. (Equivalent)	337

Bids were taken on both the revolving and conveyor type mechanism for the grit chambers, primary tanks, and final settling tanks. When bids were evaluated on

the basis of the combined cost of equipment and general construction work required for each type, contracts were awarded for the installation of conveyor type mechanisms.

Features of Particular Interest

Many of the details of design for the sewage treatment works were decided upon only after a careful study of the operation of activated sludge treatment works located in both the United States and Canada, and in conjunction with the experience of S. L. Tolman, who had for a number of years been Engineer in Charge of Operations at the North Side Activated Sludge Plant of the Chicago Sanitary District.

Certain features to be mentioned in this article have been used previously in larger plants, but are mentioned here as being unusual because the sewage treatment plants designed for Lancaster are not large and such features may be termed unusual because they have not been adopted generally in the design of the activated sludge type of treatment works. And furthermore, because it is our opinion that such items are worthy of inclusion because of their proven merit.

The diversion works provided for both sewage treatment plants, due to the sewerage system of the city of Lancaster being of a combined type, have been equipped with secondary sluice gate openings to permit of circulation and by-passing through a float chamber. Thus a continuous flow through the sewage treatment works within maximum limits will be insured. When the main control gate is shut down to by-pass storm flows, the flow through the secondary sluice gate serves to keep the float chamber free of septicization. Of greater importance, the maintained continuous flow through the sewage treatment works will keep all of the units operating with sufficient raw sewage input to keep the activated sludge in good condition.

Usually in plants the size of these at Lancaster one screen only is provided, but in this case two sets of screens have been provided in separate channels and both are to be mechanically cleaned. A recording gauge is being installed in the blower room of the main building to record the height of sewage ahead of and behind the screens in the screen house, thus giving the operator in the main building continuous information as to the condition of the screens and the charactertistics of flow of sewage through the screen house. A generous complement of alarms have been provided throughout the plant.

The incinerator at each plant is designed for the destruction of grit, screenings and scum. It has been observed from experience that even after a thorough washing grit contains offensive material which cannot be disposed of by using it as a sand fill on roads or even on dumps without producing odor nuisances. It is proposed to incinerate all such material and also the screenings from the mechanical screen together with the scum from the various settling tanks and other units.

Blowers of Variable Air Output

Two blowers, each of full and equal capacity for the application of air for the entire plant, are being provided in the main building of each treatment works. Blowers in each plant are of different types—one is of the centrifugal type and the other of the positive type. The centrifugal type is being manufactured by the Ingersoll-Rand Company and the positive type by the Connersville Blower Company. Each blower is provided with means by which regulation of the air output of the blower is controlled to conform to the requirements of the variable sewage flow, with a corresponding saving in power. Regulation of the output from the centrifugal blower is accomplished by means of a power wheel installed integrally with the blower. The regulating handle is located at the blower itself. The rotary positive type blower is equipped with a power unloader, also integral with the unit, while the motor is a two speed type thus permitting of a wide range of output with a corresponding saving of power. Both motors are synchronous type designed to maintain the power factor at unity at each plant. The blower motors at the South Plant are of sufficient capacity to maintain the power factor at unity, even though this plant has an additional power load created by the power required to operate the sewage pumping station.

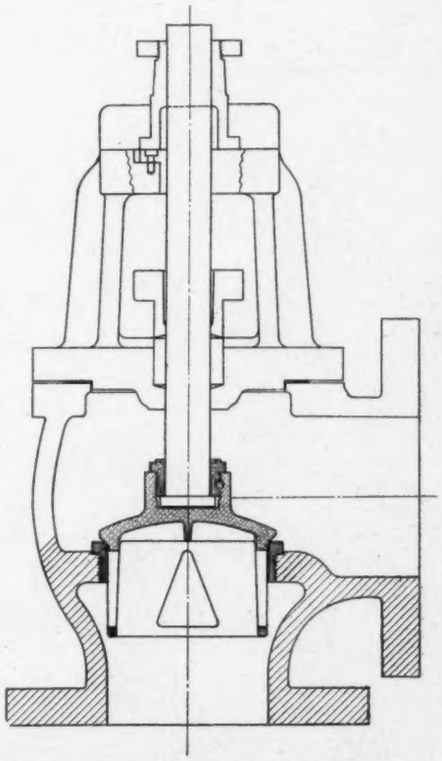
It has been observed, generally, that the rooms in which air blowers are installed have been conspicuously noisy at most plants. To minimize noise acoustical treatmeant is being applied to the blower rooms at both the North and South sewage treatment works. In addition to the acoustical treatment, the positive blowers are being insulated from the foundation by the use of vibrodampers. The foundations on which the blowers rest are insulated from the rest of the building by constructing them separately and by the use of insulating materials.

New Type Sludge Pumps

For pumping primary sludge, Chicago Screw Feed Centrifugal Pumps have been substituted for the usual plunger type pumps. Observation of these screw feed type pumps in operation at the Chicago North Side Treatment Works led to their selection.

A complete machine shop, as regards the installation of small tools, such as lathes, etc., is being provided in the main building of each plant to permit maintenance and repair work being handled right at the plant.

The heating boilers for the buildings and the sludge tanks are of the steam type, equipped with heat exchangers. The selection of steam type boilers was for



Section Through Specially Designed Air Controls and Regulating Valves Serving Individual Sections of Air Diffusor Plates at Lancaster Sewage Treatment Works.

the purpose of preventing condensation and attendant corrosion which is usually present at low temperatures where boilers fired with sludge gas are used in conjunction with hot water heating systems.

Air Control Valves of Special Design

All valves on air lines are of special design, so as to procure a more delicate throttling control than is usually obtainable with ordinary angle, globe or gate valves. It has been observed that economies in the use of air may be made possible by the manipulation of such throttling valves. In addition, there can be maintained a more carefully gauged variation of air throughout the various groups of diffuser plates in the aeration tanks with resulting economy.

The Aloxite diffuser plates, which will be 1 inch in thickness, are to be designed for a rating of 30 to 36 cubic feet as contrasted to much lower ratings at the same head which have commonly been used in the past. We felt that insufficient attention had been given in the past to the detail of specifying the relative ratings of plates of different thicknesses, as a consequence of which certain thicknesses of plates have been subjected to conditions from which they would be bound to suffer in comparison.

Two sets of air filters, to operate in series, are being provided in each plant, each set being of full capacity for the ultimate capacity of the plants. One filter is of the continuous viscous type operated by a motor and the other the ordinary mat type.

Since the main building does not extend over the entire length of the aeration pipe gallery, the concrete roof on each of the uncovered ends of the gallery is being provided with insulation to prevent condensation on the ceiling and walls of the pipe gallery. Ventilators equipped with manually opened doors and located at the ends of the pipe gallery are to serve the dual purpose of ventilating and serving as an emerging escape for the operators in case of accident.

Sludge level indicators, such as have been used at the Chicago North Side Plant for sometime, are being installed in the secondary settling tanks.

Automatic sampling pumps are being provided in the aeration pipe gallery to collect samples—one from the primary effluent, one from the final effluent, one from the mixed liquor and one from return sludge.

Special Arrangement of Gas Holders

Two gas holders are being installed, one on each of the digestion tanks at each plant. The two digestion anks at each of the plants are covered by a concrete roof in the center of which has been provided a well for the installation of a gas holder, which will float in the tank taking advantage of the sludge liquor to serve as a gas seal. This idea was proposed for use at Springfield by W. B. Walraven. Economy of construction and convenience of operation were made possible by such a design.

Two sludge storage tanks, similar to the installation made at Peoria and other more recent plants, are being constructed of the same size as the sludge digestion tanks. By such an arrangement two-stage digestion may be practiced at least to some extent, permitting likewise the storage of digested sludge prior to drying on the sludge beds. At a future date these tanks may be covered and equipped as digestion tanks if desired and even provided with gas holders if necessary.

The grounds at both sewage treatment works are provided with an underground system of piping to be used for sprinkling the lawns with sterilized effluent pumped from the contact tank at the chlorination building. In addition to the saving which will be made by curtailment of the use of high pressure filtered water, the fertilizing value of the sewage will be made available for the lawns. At Fostoria, Ohio, and Grand Canyon, Ariz., the use of treated sewage for this purpose produced a much improved lawn.

Costs

The contract price of the North Plant was $416,000 and the South Plant $476,000—the latter including the sewage pumping station being built as a part of the plant. The laboratories are fully equipped with furniture and apparatus at both plants. More than 100,000 cubic yards of excavation is involved in the construction of both sewage treatment works and about 75 per cent of which is tough limestone rock. The construction work was started early this year (1933) and is scheduled to be completed about July, 1934.

Personnel

Mayor T. Warren Metzger and the City Commissioners deserve much credit for the vision and courage they displayed in furthering the project in the face of the extreme depression and consequent financial difficulties of all communities but which, at the same time, permitted the letting of contracts at prices which were the lowest obtainable in almost two decades.

Commissioner Harry B. Cochran and Frank P. Sweeton, his successor in office, have been Directors in Charge of Streets and Public Improvements and Mr. Edward Edgerley has served as City Engineer since the inception of the program. Mr. J. H. Miller, Mr. J. E. Kesner, Mr. A. T. Lundberg and Mr. John Sherts are Resident Engineers on the sewerage improvements and the author is in charge of design and general supervision.

▼

Sewerage Projects Planned for New York Communities Receives Impetus

The following news item appearing in *Health News*, of the New York State Department of Health, is indicative of the future of sewerage projects planned in the State:

Twenty-eight sets of plans for sewerage and sewage disposal were examined and approved during November by the State Department of Health. Included were general plans for the Pocantico trunk sewer and sewage treatment project of the Westchester County Sanitary Sewer Commission. The estimated cost is $4,800,000 and the work may be undertaken with federal aid if approved by the government.

Two other projects were approved which involve an expenditure of approximately $1,000,000 each, namely, the interception and treatment of the sewage of Elmira and the construction of the Ley Creek intercepting sewer by the Onondaga County Sanitary Sewer and Public Works Commission. Plans were also approved for a complete sewer system and sewage treatment plant for the village of Aurora and for the interception and treatment of the sewage of Malone.

▼

Sewage Treatment in Iowa.—Out of the 321 cities and towns in the state of Iowa having sanitary sewer systems, 217 already have some form of sewage treatment; 50 of the 93 second-class cities in the state have sewage treatment; 65 of the 85 towns between 1,000 and 2,000 population have sewage treatment; 82 of the 105 towns between 500 and 1,000 population have sewage treatment.

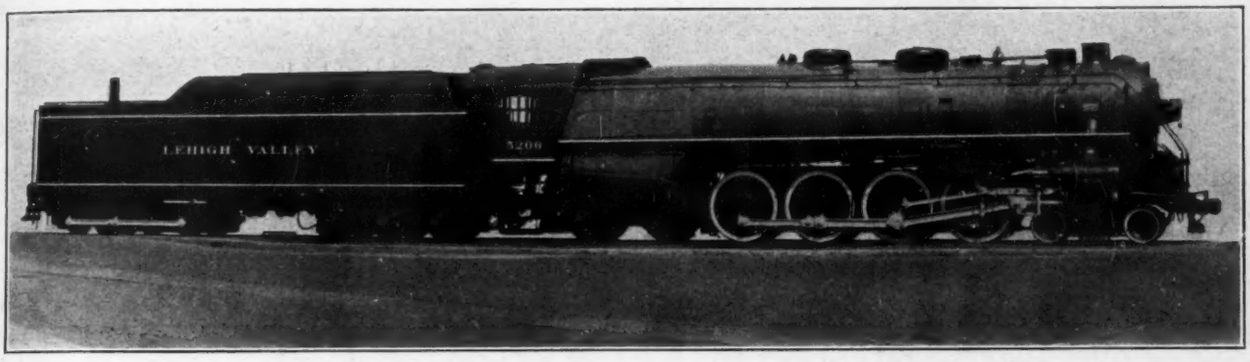
WAYSIDE WATER TREATMENT ON THE LEHIGH VALLEY RAILROAD

By J. V. CARDILLO

Water Inspector, Lehigh Valley Railroad, Sayre, Pa.

THE development of more efficient and more powerful locomotives, and the use of steam motive power to a point more closely approaching its full capacity, has made the quality of boiler feed water assume greater importance than at any time in the history of railroading. The demand for greater steam output requires boilers which will stand up under heavy steam demands and boilers which can be kept in service without road failure for an extended period of time and mileage. Evaporation of increased quantities of inferior feed water has resulted in faster accumulation of scale in the boiler. This leads to many deleterious effects among which are overheating, leaking, bulged arch tubes, corrosion, increased fuel consumption and greatly reduced serviceable life of flues, sheets, fireboxes and staybolts.

Prior to 1929 the locomotive boiler work on the Lehigh Valley Railroad exceeded any other class of repairs.



Newest Type of Motive Power on Lehigh Valley System. It Costs Money to "Shop" One of These.

Extensive investigation and study of engines undergoing repairs showed that this was largely due to the inferior quality of the water supplies. A study was then made of every source of water on the entire railroad—as to facilities at the location, quality of water and the quantity consumed. At this time water consumption on the road was approximately 4,215 million gallons per year, of which only a minor part was being treated.

Need for Extended Water Treatment Recognized

In 1929 a Water Committee was formed, consisting of J. N. Haines, General Manager, J. P. Laux, Superintendent of Motive Power, G. A. Phillips, Chief Engineer of Maintenance, F. E. Lyford, Special Engineer, and J. J. Laudig, Chemical Engineer. The committee studied the report made on the quality and condition of the locomotive water supply on the system and a general program of improving quality in accordance with present operation conditions was instituted.

As the program developed, it was quite apparent that it was necessary to have someone directly in touch with water conditions, supervising and coordinating treatment, checking quality, and educating and instructing the roundhouse forces and engine crews in the use and value of treated water. It was at this time that the position of Water Inspector, now held by the author, was created.

External lime and soda ash plants and sodium aluminate wayside plants were recommended for terminals, the selection being determined by the character of the water available and the cost of treatment. However, for intermediate points it was found that wayside plants would be more economical, because the consumption of water would not warrant extensive expenditure and equipment for these small plants could readily be moved. An important objective in the program of improvement was that of decreasing the number of points of supply, including those of inferior quality. Wayside plants for this reason were very desirable.

Since it required some time to make tests on the types of automatic wayside plants to be used and the results obtained by each method, the Water Committee approved the temporary treatment of locomotives at strategic points by means of boiler compound, added to engine tenders, until such times as an automatic method of application could be installed. This treatment was handled by the roundhouse men and its success depended upon the proper and regular application of the compound.

Automatic Wayside Treatment Held Promise

In order to judge the merits of the automatic wayside method of treatment, the National Aluminate Corporation who have been successful with this method of treatment on many railroads, were given an opportunity of proving the value of sodium aluminate wayside treatment at the Catasauqua, Pa., water station. The opportunity for study at this point was excellent because the raw water contained approximately twelve grains of incrusting solids and the supply was used largely by one switching locomotive.

The sodium aluminate was introduced into the water by means of a chemical proportioning pump, driven by a water motor, which delivered the chemical into the intake water line. The speed of the water motor being proportionate to the rate of flow of water through it, insured accurate proportioning and feeding of the sodium aluminate solution. The plunger on the chemical pump is so constructed that the amount of chemical can be varied at will whenever necessary. (See illustration.)

The product used in the test contained sodium aluminate, sodium hydroxide and tannin, compounded in liquid form, the amount used being determined by knowing the quantity of incrustating sulphates in the raw

water. The reactions are completed within the locomotive boiler, the scale forming matter being coagulated to a flocculent sludge, later to be removed from the boiler by blowing down.

The test at Catasauqua proved very successful, the yard engine now remaining in continuous service between monthly inspections. Prior to water treatment it was returned to the South Easton Round House for running repairs twice weekly. In addition to neutralizing the scale forming sulphates entering the boiler, the treatment gradually softened and removed the hard scale adhering to the boiler metal.

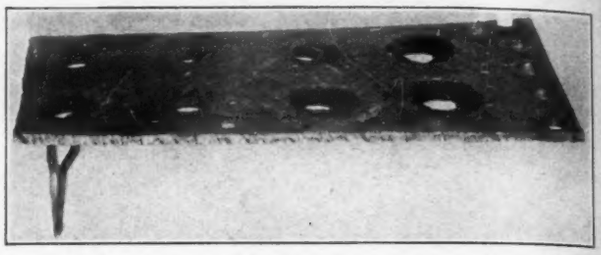
On the basis of the results of this test at Catasauqua, wayside treatment of engine supplies was extended next

Typical Installation for Wayside Treatment. "Nalco" Water Motor and Proportioner Installed in a Water Column Pit. The Equipment Proportions Concentrated Aluminate Solutions to the Water Enroute from the Tank to the Locomotive Tender. At Other Points the Proportioner Is Operated by Electric Motor.

to the Auburn Branch of the Buffalo Division. There were twenty-three points of water supply on this division, the water varying in hardness from 2 to 50 grains per gallon, and the consumption of water at most of these stations was insufficient to warrant expensive treating equipment.

Authorization was given for the installation of eight wayside treating plants at points where the greatest possible benefits would be obtained. Therefore, the plants were installed at terminals, junctions of branches and points so located as to give treatment to the maximum quantity of the poorest quality of water which had to be used—it being practical to treat the water for a slight excess to create a reserve of chemical to react with additional water taken at points where no treatment had been provided.

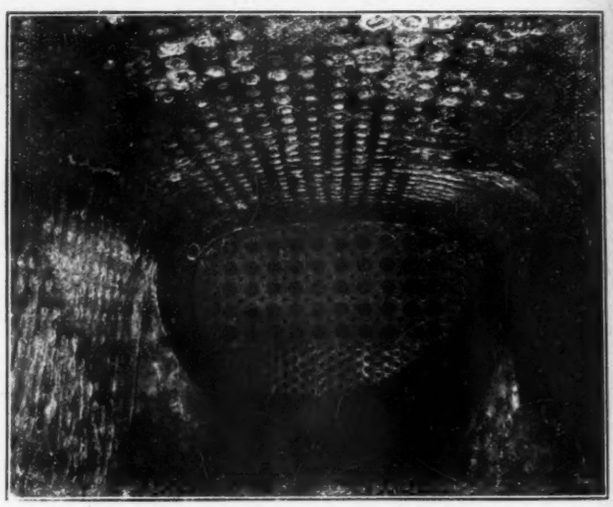
The chemical proportioner in these newer plants is of the same type as that used at Catasauqua. However, the scheme of motivating the proportioners was varied to suit conditions. At points where there were steam or gasoline-driven pumps, the proportioner was operated by direct connection to the plunger arm or crosshead of the engine or pump. Where the electric motor drive was used, it was necessary to install pressure mercoid or mechanical switches in the discharge line so that when the water flowed through the line, the switch would make contact, thereby operating the chemical proportioner. Other types of control used were flow switches and differential pressure switches. Regardless of the type of



A Crown Sheet Removed from a Locomotive, Showing the Grooved Condition of Metal Which Was Discovered After Treated Water Had Loosened the Scale Deposits.

drive used, the pumps were all subject to adjustment to deliver the required amount of chemical, or determined by the incrustating sulphates in the water and the quantity of water pumped.

These plants were placed in operation the latter part of 1930 and the immediate results of the treatment, from the layman's point of view, were not gratifying. Boiler leaks increased and there was a considerable amount of foaming trouble. This condition was a natural sequence of the treatment because the locomotive boilers on this branch were in a badly scaled condition. When the old scale was removed, leaks developed at every loose joint in the boiler. The loosened scale also greatly increased the dissolved and suspended matter, which temporarily increased tendencies toward foaming.



Interior of Leaky Firebox Caused by Bad Water. Notice the Attack on Metal Around Rivet Heads.

After a short period of time, analyses of the boiler water and inspection of the boilers when washed indicated that the small number of wayside plants on this branch was insufficient to condition the total amount of water used for the locomotives. The number of plants was then increased and many supplies, which showed the poorest quality, were abandoned in order to secure better water and to concentrate the consumption at the points where the water was treated.

"Wayside" Treatment Extended on Merit

The automatic wayside plants were so successful that the use of boiler compound which had been added man-

ually at strategic points was gradually discontinued. To date, the number of automatic wayside plants has reached twenty-eight, all of which are operated satisfactorily as shown by the clean condition of boilers, decreased maintenance and increased locomotive operating efficiency. These plants require very little maintenance, from the mechanical standpoint, ordinarily requiring only a monthly inspection and lubrication, in addition to a periodic inspection by the water inspector.

Sodium aluminate is received in tank cars and pumped into a storage tank located at the general storehouse at Sayre, Pa. It is then shipped in fifty gallon drums as needed, to the various treating stations.

A large number of stationary boilers at points where there is no complete treating plant are also being supplied water treated with sodium aluminate. Prior to treatment the boilers were washed and the tubes turbined every thirty days on the average. At the present time, these boilers operate in continuous service for a period of four months, at the end of which time they are washed out but no turbining or scaling is required.

Although this article deals specifically with wayside treating plants, sight should not be lost of the fact that soda, lime, aluminate plants, of which we have three, play an important part in our program. These are located at points of maximum consumption and hardness. One of the most outstanding plants of this type in the country is located on the Lehigh Valley System at Manchester, N. Y.

Systematic "Blow-Down" Important Feature

As the water treating program progressed, it became necessary to change past practices. The washout method, the handling of the blow-off cocks, etc., were revised. The successful use of water treatment is greatly dependent upon the blowing down of the locomotive boilers systematically. The blow-down does two things—it removes the mud and sludge around the base of the boilers and reduces the soluble solids concentration in the boiler, thereby preventing foaming.

A system of terminal blow-downs was inaugurated when water treatment started, this being a very important part of any program of water treatment. The engines were blown down upon arrival and departure by the roundhouse forces. The length and frequency of this blow-down was determined from studies made of boiler concentration in various treated water districts, for various classes of power and service. Study showed that for certain classes of service, terminal blow-down was insufficient, and in order to secure additional necessary blow-down, and to have this effectively and safely carried out, blow-off cock handles were extended to the locomotive cab, in order to permit blowing down of engines on the road. Locomotives have also been equipped with mufflers for safety purposes and for the elimination of noise. Credit is due to the road foremen of engines and engine crews for the spirit with which they have assisted in this program. Their cooperation has made it possible to make long runs with very infrequent foaming trouble and practically all power is now on a monthly washout schedule, replacing the previous practice of fifteen day washouts.

The control of blow-downs and elimination of foaming and water change is accomplished by studies made with densimeters for determining the concentration of the boiler water. This work, which had readily become standardized for various classes of power, is done by roundhouse foremen under the direct supervision of the water inspector. Such a procedure enables the foreman to determine whether engines have been properly blown down or whether the cause of the engineer's report to change water is the fact that he has been carrying "high water" and getting it into the cylinders.

Another important feature in the training of all concerned with the handling of engines, is that of cooling and washing of the boilers as soon as possible after being drained, thus preventing the soft sludge from baking at the heating surface. Washout plugs have been applied to the barrel of boilers, facilitating the removal of sludge and sediment, it being found that a large proportion of these deposits were otherwise inaccessible.

The Functions of the Water Laboratory

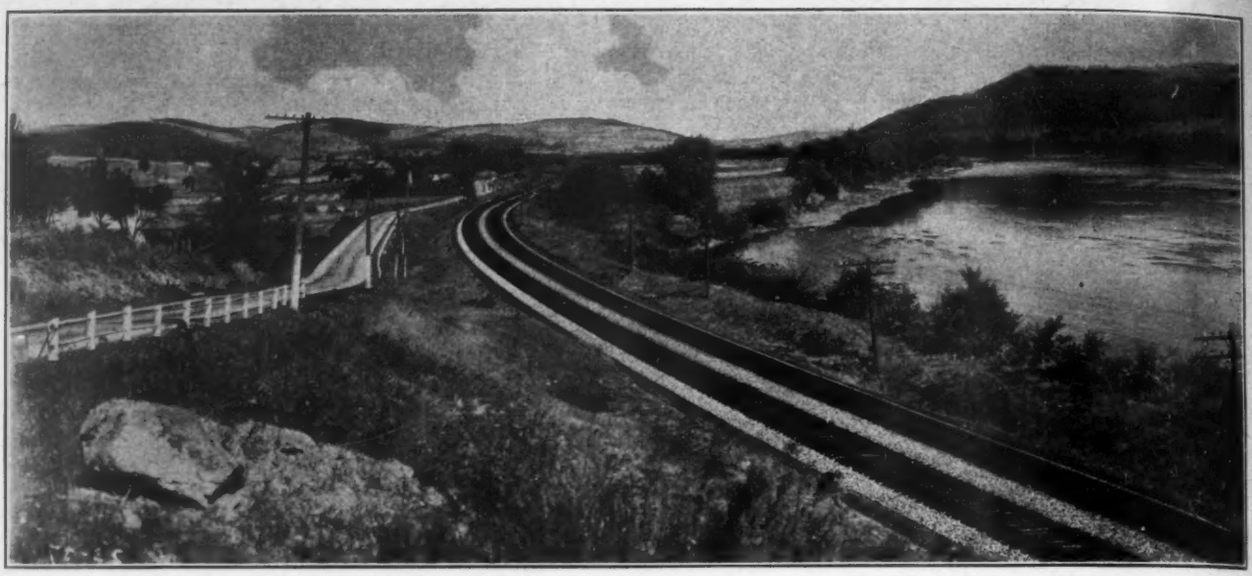
A water laboratory is located at Sayre, Pa., where weekly samples received from wayside plants are analyzed. In addition, this laboratory determines whether sufficient treatment is being applied to water used by various classes of engines for the particular service, and stationary boiler treatment is also controlled by the laboratory. After analysis of the weekly samples from the wayside plants has been made, should there be any changes in treatment necessary, the Maintenance of Way Department is notified and the changes are made by them.

Records are kept showing the quantity of chemical

Water Station, Cayuga Junction, N. Y. Typical Wayside Treatment Station, But Who Would Know It? The Equipment and Solution Tank Being Located Beneath the Water Tank Require But Little Space.

used at each plant, and these records make possible the calculation of the water consumption at points where water meters are not available. Investigation is also made of water rates charged the railroad, with a resultant decrease in rates in many cases and in other cases the source of supply has been changed. Cognizance, in all cases, was taken of the quality of the water supply in question. Records are also kept of the analysis of raw and treated water, which show the seasonal changes, range of treatment and characteristics of various types of control, in addition to tests and data on the operating efficiency as compared with results obtained in the shops and roundhouses.

For the mechanical performance of the plants, the Maintenance of Way Department is responsible for maintaining and insuring operation. However, the water inspector has charge of inspection of the plants, analyzes the water and decides the amount of treatment necessary. Cooperation, therefore, between the water inspection and Maintenance of Way Department is essential, since their work is so closely related. It is also



Along the Lehigh Valley's Right-of-Way. Beautiful Scenery But Hard Water Much of the Way.

necessary in order to follow up treatment from the practical standpoint, for the water inspector to work with D. A. Stark, General Boiler Inspector, consulting and reporting jointly with him on the condition of boilers receiving treatment.

Results from the Water Treatment Program

Increased flue life, increased period between washouts, increased firebox life, decreased fuel consumption and many other favorable conditions are becoming more and more evident to the mechanical department as a result of the water treatment program. Less than three years of supervised water treatment has shown a marked reduction in the roundhouse and back shop boiler work. This is particularly true of the Auburn Branch of the Buffalo Division, where all important water stations are equipped with sodium aluminate wayside plants and on the Buffalo Division of the main line where wayside plants and external treatment are used.

Prior to systematic water treatment and improved lubrication methods on the Buffalo Division, it was necessary to maintain running repairs at six roundhouses. The improved lubrication and bettered boiler conditions, particularly evident the past eighteen months, have enabled the mechanical department to handle this work at two roundhouses.

Despite the concentration of boiler work at the Sayre and East Buffalo roundohuses, the following tabulation clearly shows the reduction in engine house boiler repairs on the Buffalo Division since controlled water treatment was inaugurated:

Work Required	% Reduction
Arch tube renewals	75
Firebox patches	87
Staybolt renewals	81
Crownbolt renewals	91
Boiler course patches	66
Flue renewals	97

The back-shop work has been materially reduced; for instance, the ten Tifft terminal switchers averaged five sets of flues from 1924 to 1929. Since 1929 the average for the same ten switchers has been one set of flues. The actual savings made possible by the increased life of flues of the ten locomotives has been $4,784.00 per year, or $478.40 per switcher per year. This figure is certain to increase with passage of time and continued treatment of water. As a matter of fact, a one year extension has been granted by the inspection department beyond the four year limit for the flues of one of these switchers. Treatment of water has made possible the granting of extensions on flues on four locomotives at other points in addition to the Tifft terminal switcher.

The locomotives of the Auburn Branch of the Buffalo Division had a flue life of three years. However, since water treatment has been introduced the trend of life seems to be toward a four year limit with the possibility of extension. There has also been an increase ranging from 23 to 31 per cent in miles per set of flues, varying with the territory and the extent of treatment in engine operating districts. In terms of years, the average life of flues has been extended from two and one-half years to nearly four years and there is indication that the four years average will be exceeded. The locomotives operating over the main line of the Buffalo Division are showing a definite increase in flue mileage for the first time since the locomotives were built, in 1923. The flue mileage has been doubled on the main line engines and the decreased shopping caused by lessened boiler repairs and improved lubrication has permitted the division to be operated with fewer locomotives in service and with obvious increased savings in operation. For the first time in the history of the Lehigh Valley Railroad, ten Buffalo Division locomotives have been received at the Sayre shops for general shopping and no boiler work is scheduled.

The twenty locomotives which have been operating from Buffalo to Jersey City since they were placed in service in May, 1932, are average 6,000 miles per month or 72,000 miles per year. To date the boilers are clean, free of scale, and being in such excellent condition, there is no apparent reason to doubt that the full life of the flues will be obtained and long firebox and side sheet service may be expected in addition.

The treatment of locomotive water on the Buffalo Division has been in progress a sufficient length of time to bring about the benefits listed above. Other divisions, where corrective treatment of the water has not been applied as long, are showing comparable improvements in locomotive conditions. It is understood, however, that the improvements now being shown in the condition of locomotives on all divisions are but part of that eventually attainable. Further study and improvement of the water supplies, their treatment and the results secured in the use of the water, will all result in greater efficiency.

The results obtained to date have been due to the cooperative effort of all departments and individuals.

MEETING OF THE VIRGINIA WATER AND SEWAGE WORKS ASSOCIATION

OUR December issue carried a report of the meeting of Virginia Water and Sewage Works Association, held at Newport News, Va., on November 16-18, 1933. Due to lack of space only a part of the digest of papers read and discussion which followed could be printed. This installment completes the report.

Short Papers and Talks on Operating Problems

"Correcting Troubles Experienced with an Open Service Reservoir"—R. L. WARREN, Superintendent, Water Works, South Boston, Va.

Inlet and outlet arrangements on the open service reservoir at South Boston had resulted in inadequate circulation and displacement of the water. In consequence, considerable difficulty had been experienced with algae growth and resulting complaints by consumers. To combat the difficulty "H.T.H." (a powdered high test hypochlorite) had been applied to the surface of the reservoir at intervals. The use of the ammonia-chlorine process, since, had made it possible to carry a higher residual chlorine content into the reservoir and thereby secure a more efficient control of algae growths. Because the filtered and chlorinated water had to pass through the city to the reservoir, and only the surplus above consumption reached the reservoir, it was not possible to carry more than 0.15 p.p.m. residual chlorine without use of ammonia. Since starting the ammonia treatment, however, 0.35 p.p.m. residual could be maintained at the reservoir inlet without complaints being registered, but somewhat less was being maintained in routine practice. Plans were being made to rearrange the reservoir inlet to provide improved displacement and the reservoir would also probably be covered later.

To keep toad frogs from jumping onto the coping and into the reservoir a low "frog-fence" designed and installed by them, which had proven an effective barrier, was described by Mr. Warren.

"Coagulation Difficulties Solved by Use of Well Water to Adjust pH Value"—B. S. PARRISH, Superintendent of Utilities and Public Works, Martinsville, Va.

Mr. Parrish related their difficulties with proper alkalinity control and pH regulation in coagulation practice, involving use of soda ash and alum. They had hit upon the idea of mixing water from the wells, held as auxiliary supply, with the creek water whenever its alkalinity was deficient. That practice had made effective coagulation control simple. Because of a low power cost for pumping the well water and reduced consumption of alum, pH adjustment with well water had been less costly than when soda-ash was employed. In addition, floc formation had been quicker, the floc heavier and more rapid settling. They had also found return of sludge to the mixing chamber helpful in floc formation and arrangements for so doing had been installed.

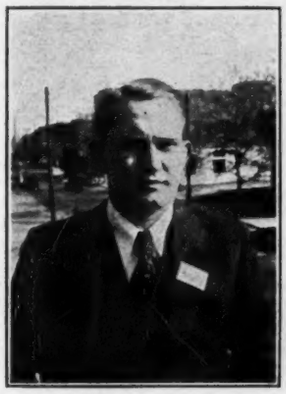
J. N. PHELPS, President, Phelps' Water Co., Roanoke, Va., described an ingenious and inexpensive scheme for insuring displacement of water in small reservoirs which float on distribution systems. In this the inflowing water entered through a riser pipe, on the inlet-outlet line, to the surface at one side, the outflow being taken from the bottom at the opposite side. A check valve in the outlet leg prevented inflow through it, thus causing the water to flow upward through the riser to the surface against the somewhat greater head.

E. F. DUGGER, Manager of Water Works, Newport News, Va., related some of the advantages he had found in an installation of modern types of check valves on the discharge side of high pressure pumps. As a result there had been reduced friction head and a consequential saving in power, the new type hydraulic check valve having displaced an old style check and two hand-operated gate valves.

Pumping and Water Measurements

"Pumping Problems and Power Requirements"—ALLAN J. SAVILLE, Consulting Engineer, Richmond, Va.

Mr. Saville briefly compared the advantages of pumping water with power from steam plants, Diesel engines and electric motors, in which he pointed out the overall desirability and economy of electrically operated centrifugal pumps and standby gasoline or oil engines for emergency operation. Especially was this true, he remarked, for small stations where keeping a man on duty continuously was not justified. With properly designed systems the power "demand charge" or "readiness to serve charge," commonly complained of by water departments, could be materially reduced. Sufficient attention, in his opinion, had not been given to providing adequate "ready to serve" water storage and it could frequently be shown by a study of this problem that, with properly designed storage, a municipality could profit materially by avoidance of the otherwise necessary high capacity pumping during periods of heavy consumption.



R. L. Warren, Superintendent Water Works, South Boston, Va.

Prof. F. H. Fish, Virginia Polytechnic Institute, Blacksburg, Va.

The high "demand charge" paid power companies could be reduced by about 50 per cent provided all pumping, or a goodly portion of it, could be done at municipal plants between 7 p. m. and 7 a. m. Storage reservoirs or elevated tanks properly located on the system would render practical a very flexible pumping schedule. He wondered why municipalities, especially small towns, continued to pay a high "demand charge" to power companies when storage would avoid most of it, and produce a worth-while net saving and much less worry to the local water works superintendent.

"Water Measurements"—P. H. MCGAUHEY, Associate Professor of Sanitary Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

Professor McGauhey's paper comprised a discussion and explanation of the Venturi tube, orifice plates, and Pitot tubes used in measuring water flows. The develop-

ment of the formulae used in converting differential head into volume of flow, the several factors involved, and the limitations of each device were explained.

It was one of those papers which are always valuable in refreshing the memories or adding to the knowledge of practicing engineers and operators and for instructing men recently entering the field. In referring to Venturi tubes in use, he stated that those on the New York Water Supply with capacities of 700 to 800 million gals. per day were the largest. The smallest installation measured as little as 1.5 gal. per hour. These extremes were indicative of the tremendous range of this flow measuring device. Throat velocities could be 3 to 40 ft. per second, but 28 ft. per second was usually considered the practical maximum.

ALAN WOOD, Engineer, Builders Iron Foundry, Philadelphia, Pa., in discussion, pointed out the difference

P. H. McGauhey, Virginia Polytechnic Institute, Blacksburg, Va.

Alan A. Wood, Builders Iron Foundry, Philadelphia, Pa.

between turbulent flow and helical flow through Venturi tubes. It was the latter which was undesirable and helical flow was created by obstructions just ahead of Venturi tubes, including elbows and valves. Concerning the errors of the tubes, a deposition on the interior surface of the throat gave high readings and worn throats low readings. Concerning the wear on throats, a tube in service for 25 years on the Baltimore Sewerage System had been carefully examined recently. The throat tube was clean and the wear had been but 1/10,000th inch in horizontal diameter and 1/1,000th inch in vertical diameter, but wear from silt laden water would be greater, of course. He called attention to the error in Venturi tubes which was caused by air entering the main above the tube. Any air present would be measured and recorded as an equal volume of water and should be avoided.

H. G. CHESLEY, JR., Starke Foundry & Manufacturing Co., Richmond, Va., presented a discussion prepared by Hubert Smith of Simplex Valve and Meter Company, in which the wide application of Venturi tubes was set forth—including their use at sewage works for measuring compressed air, returned sludge and excess sludge as well as the sewage proper. He described a tube with a flat bottom, designed especially for sewage and solids laden liquids generally. He also pointed out the utility of Venturi tubes for measuring reversals in flows, i.e., one tube being sufficient to serve in recording flows into and out of reservoirs or tanks and thereby show peak draughts, daily balance between input and output and other information with a single device. Mr. Smith stressed the importance which should be attached to the reliability and experience of manufacturers of water measuring equipment when contemplating purchases.

"Sprinkler Systems for Coal Dumping Piers"—S. E. SILCOX, Engineer, Water Service Department, C. & O. Railway, Richmond, Virginia.

Mr. Silcox discussed the problem of prevention of nuisance from dust around coal dumping piers. A sprinkler system had been devised for wetting the coal dumped into ships by turning gondola cars upside down—one car at each dump. The operation required quick opening and closing gate valves creating a heavy water hammer which had been overcome with a 3-in. hammer relief mechanism. A Golden-Anderson elevation control valve had been used to effectively control the pressure on the system uniformly at each sprinkling installation regardless of the number in operation. Water consumed (applied) per sprinkling and total consumption was recorded by an 8-inch Sparling type meter. Mr. Silcox then described, among other details, the size, type and spacing of spray heads developed for the installation.

Symposium on Sewerage and Sewage Treatment

"Recent Developments in Treatment of Sewage"—WELLINGTON DONALDSON, Fuller and McClintock, Engineers, New York City.

Mr. Donaldson reviewed the progress being made in sewage treatment by chemical methods. He stated that chemical treatment had two distinctive fields of usefulness, i.e., used alone as an intermediate treatment between plain sedimentation and activated sludge treatment or employed as an adjunct to biological processes. It seemed to be established that chemical precipitation, involving the use of 400 lbs. of ferric salts per million gallons and lime sufficient to produce maximum coagulating efficiencies, could be counted upon to remove 70 per cent of the oxygen demand requirement. Mechanical straining or filtration of the effluent would increase the removal to 75 or 80 per cent and if Zeolite was used as the filter medium a further reduction to 90 per cent or better could be obtained. The last, which equalled the performance of the activated sludge process, had been developed in the Guggenheim Laboratories and since demonstrated at Chicago.

Mr. Donaldson discussed briefly the several chemical-mechanical processes under development, the Laughlin

Wellington Donaldson, Consulting Engineer, New York City

A. L. Meisel, City Manager, Williamsburg, Va.

process being that used for two years or longer at Dearborn, Mich. As the only treatment given the sewage at Birmingham, Ala., a plant was now under construction to utilize "chlorinated-copperas" as the precipitant and the principle of sludge return to the crude sewage during summer operation. The sludge was to be digested in heated tanks.

Application of chemical precipitation as an aid to biological processes could be found at Plainfield, N. J., where ferric sulphate and chlorine was to be applied to

the effluent from the sprinkling filters. The sludge collected would be pumped to the crude sewage and more ferric sulphate added with it when necessary. The mixed sludges were to be digested in heated tanks.

At Oklahoma City, Okla., ferric chloride, continuously produced in chlorinating towers filled with scrap iron and tin cans, applied to the crude sewage, had relieved odors and improved operation of the existing Imhoff tank plants. The same process had been used at Farmer, Perry, Enid and Cordell, Okla.

At Essex Falls, N. J., ferric chloride applied ahead of precipitation tanks supplying slow sand filters has abated a nuisance. At Grand Rapids, Mich., it had been demonstrated that moderate dosages of ferric-chloride improved the efficiency of solids and oxygen demand removal through clarifiers. At Rockville Centre, L. I., vacuum type mechanical filters had been installed to operate with paper pulp added to the settled sewage for the purpose of removing the load on the activated sludge process. One filter served to remove the suspended solids from the plant effluent. Mechanical sand filters had been installed as the final units at several plants.

Chlorination could be relied upon to reduce oxygen demand of settled sewages by 25 per cent and was being more widely employed for effective odor control and stream improvement.

In sludge dewatering the use of mechanical vacuum filters with ferric salts was now established as practical and economical and was in use at a number of plants. At Hagerstown, Md., mixed screenings, crude solids and activated sludge was being dewatered with paper pulp and lime added ahead of the vacuum filter. At Baltimore a scheme of washing sludges with water prior to chemical conditioning was under development and showed promise.

Incineration as a means of disposal of sludge cake had been adopted at Dearborn and was being planned for several other places. At Plainfield digested sludge was to be dried in a spray drier and disposed of for its fertilizer value.

G. J. REQUARDT, Consulting Engineer, Baltimore, Md., said that vacuum filtration of sludge would be utilized at the Annapolis, Md., plant (3 m.g.d. capacity). Incineration of crude solids had been considered but a 5-ton plant seemed to be the low limit for practical reasons and therefore sludge digestion had been decided upon in conjunction with vacuum filtration. For odor control and disinfection prechlorination was to be provided at a pump station some distance ahead of the treatment works.

L. H. ENSLOW reported that the new plant at Birmingham, Ala., was to be provided with a rapid filter for polishing up the effluent and that coarse grained anthracite coal would constitute the filter media because of its ease of washing (light gravity). Effluent was to be used in the washing operations. The Birmingham scheme had been patterned after that developed by R. A. Stevenson of the Great Western Electrochemical Company on the Pacific Coast but the design was so flexible that the plant could be operated in several ways. "Chlorinated-copperas" was to be used because of the abundance of ferrous-sulphate produced in Birmingham and low cost of chlorine.

At Oklahoma City the most interesting development had been the odor control and efficient coagulation resulting from ferric chloride introduction well up the sewer. The precipitated iron was taken out by the Imhoff tanks and the plant had for the first time been operated without odor nuisance and foaming. Introduction of packing house wastes into the sewer had been largely responsible for the difficulties corrected with "home-made" ferric-chloride from tin cans and chlorine.

"The New Sewage Treatment Plant at Williamsburg, Va."—L. A. MEISEL, City Manager, Williamsburg, Va.

Mr. Miesel described the new sewage treatment works for Williamsburg, Va., which will include a detritor, Venturi meter, two clarifiers, two sprinkling filters, two sludge digesters, final settling tank, a gas holder and glass covered sludge beds. On the same site will be built an incinerator and all buildings are patterned after the colonial architecture of the town and the College of William and Mary, there located.

The sprinkling filters, 6 ft. deep and 110 ft. 6 in. in diameter, are to be equipped with "Dorrco" revolving distributors. The clarifiers, of the center feed Dorrco type, are 35 ft. in diameter with a 7 ft. water depth at the

H. W. Easterly, Richmond, Va.

G. J. Requardt, Consulting Engineer, Baltimore, Md.

periphery. Digesters will be heated and surplus gas was to be used for operating the garbage-can washing and sterilizing plant at the incinerator. Automatically operated chlorinators will provide prechlorination for odor control and post-chlorination for disinfection at the inlet to the final settling tank. The sludge beds are to be divided into small sections to facilitate frequent sludge drawings of small amount. Humus sludge from the final tank will be dewatered without digestion. The plant will be equipped with a small laboratory.

"The Use of Concrete Pipe for Sewers"—HARRY W. EASTERLY, Vice-President, Concrete Pipe and Products Co., Richmond, Va.

Mr. Easterly discussed plain and reinforced concrete pipe for construction of trunk sewers and laterals. He referred to the so-called gas attack on concrete and other masonry interceptor or outfall sewers in localities where the temperature was high and sulphate content and age of the sewage relatively great. This problem, however, did not extend to the lateral system and therefore use of concrete pipe for laterals was safer practice than its use in trunk sewers. Milwaukee had 900 miles of concrete laterals and Detroit, with its 57 million dollar investment in concrete sewers, had been using concrete pipe for laterals since 1909. Where concrete sewers had failed, the chief cause had been found to be poor trench bedding, and careless back filling. The second cause had been the acid attack as result of the sulphuric acid produced from the hydrogen sulphide expelled from old sewage high in sulphates. He referred to the Los Angeles sewage, much of which traveled 50 to 60 miles through the system and was 12 to 18 hours old before reaching the ocean outfall. Such a condition had resulted in the failure of two brick sewers before the present trunk sewer of concrete with clay liner plates had been built. Concrete laterals had not been attacked. Mr. Easterly stated that the American Concrete Pipe Asso-

ciation stood ready to give advice on methods of avoiding sewer gas attack where the problem was likely to be met.

"The Sewerage Program for Arlington County, Va."—A. B. McDANIEL, Chief Engineer, Sanitary Division, Arlington County, Va.

Mr. McDaniel said that Arlington County with its $2,500,000 P.W.A. allotment was planning two major drainage districts to serve a future population of 130,000 persons. The new systems were expected to be completed in two years. The program included construction of two treatment plants, one of 4 m.g.d. and the other 2 m.g.d. capacity, to provide effective clarification and prechlorination. The Arlington County authorities were conferring with the District of Columbia Board of Engineers in working out the scheme of disposal, degree of treatment advisable and plant locations, the minimum dilution afforded by the Potomac River being 7 to 1. The town of Falls Church was likewise planning on sewers and sewage treatment if P.W.A. funds could be procured. The Arlington County application for P.W.A. assistance had been cleared in the short period of 15 days, 5 days in the State Engineer's office and 10 days in Washington. Sewers and pumping stations would cost $1,275,000 and the treatment plants but $125,000.

"Sewage Pumping"—NORMAN Z. BALL, Principal Assistant Engineer, Department of Public Works, Norfolk, Va.

Mr. Ball explained that he was "pinch-hitting" for W. H. Taylor, Director of Public Works, who had been prevented from presenting a talk on this topic because of an automobile accident.

Because of the lack of natural drainage, Norfolk has to depend on numerous pumping stations serving small areas drained to central points—there being 21 such stations in operation at present. Mr. Ball stated that sewage pumping dated back to 1885 in Norfolk and they probably had the earliest installation of a centrifugal sewage pump, with vanes resembling a paddle wheel. Known as the Cataract pump, it was still doing auxiliary duty. The next installation was a centrifugal designed by a previous City Engineer and the Morris Machine Works. It was direct connected to a compound steam engine and had a 13 m.g.d. capacity. The next improvement of note in sewage pumps installed in Norfolk was the Wood Trash Pump which was first supplied by the Fairbanks Morse Company and since by other pump makers. Electrically operated pumps have replaced steam operated units with considerable saving in operating cost. Two independent power feed lines into each station insured uninterrupted service. One steam driven unit had operated practically continuously for 40 years before being replaced by electric-driven pumps.

In recent installations the motors have been placed down in the dry well direct connected to horizontal pumps. With careful concrete pouring it has been possible to make the pump pit practically dry and ventilation has been sufficient to preclude condensation.

A scheme first used in Norfolk and since at New Orleans and Portsmouth, Va., which will receive more attention in future sewage pumping, consists of a syphon arrangement of air tight cast iron pipe connecting numerous sewage collecting wells to a central pump station. At the high point in the syphon line, a steel vacuum chamber is connected to each central station by an air exhaust line which is used to prime the syphon as often as required.

Mr. Ball said that during the past 10 years, since he had taken charge of the sewerage system, electrification of pumping stations and other economies had brought about a reduction of operating costs from $113,000 to the present figure of $66,000 per year,—notwithstanding an increase of sewer lines and drains from 196 to 296 miles. The cost of operation and maintenance of sewers and pumping stations was now $223 per mile per year (51 cents per capita per year) as against $577 ten years ago.

▼

Sealing Abandoned Mines

Work on sealing abandoned coal mines for the protection of public water supplies has been begun in Ohio and adjacent states, according to the Ohio Health News of Jan. 1. This CWA project is being carried out under the direction of the U. S. Public Health Service with a special allotment of funds made available by the Federal Government for this specific purpose.

Group Photograph, Virginia Water and Sewage Works Association Meeting

The purpose of this project is to correct the pollution of streams caused by acid water flowing from abandoned mines. By closing these old abandoned mine openings, air will be excluded from the workings, thus stopping the oxidation of iron pyrites and preventing the formation of sulphuric acid. It is not the intention to stop the flow of water from the abandoned mines entirely but rather to change its chemical character so that it will be a normal ground water such as a hillside spring.

Owing to the fact that oxidation will go on in the old abandoned mine openings as long as the supply of oxygen lasts it will be some time after the openings are closed before a material change in the character of the mine water may be noticed. Likewise, the acid water now in these old mine workings must gradually be replaced by fresh ground water before the outflow will be bettered materially.

The correction of stream pollution by acid mine water will not only protect public water supplies from contamination but will also result in material benefits to property owners by making streams available for stock watering which are now unfit for that purpose. In some of the larger streams in the coal field districts it is expected that the project will bring about sufficient improvement in the condition of the water to permit the re-stocking of these streams with the types of fish life with which they formerly abounded.

MEETING OF NORTH CAROLINA SECTION OF THE A. W. W. A. AND NORTH CAROLINA SEWAGE WORKS ASSOCIATION

IN our December 1933 issue there appeared an incompleted report of the meeting of the North Carolina Section of the American Water Works Association and the North Carolina Sewage Works Association, which was held November 13-15, 1933, at Statesville, N. C. The digest of papers read and the discussion which followed is completed below.

Tuberculation of Mains and Corrosion Control

An interesting feature of the Round Table was the discussion of corrosion prevention by raising the pH value of waters. Some of the high lights of the discussion follow. Once a main has become badly tuberculated, the use of lime to produce a slight protective coating will suppress further growth of tubercules, but there yet remained the friction loss and lowered carrying capacity of the main to be considered. To overcome this undesirable feature, main cleaning should be resorted to first and thereafter further tuberculation might be held in check by addition of lime to the water to raise the pH. It would be found, in fact, that frequently tubercules would grow slowly from beneath, even though a slight lime (calcium carbonate) coating had been deposited on the interior of the pipe. Where waters were very low in hardness (less than 35 p.p.m. calcium bi-carbonate hardness) the use of lime was not materially helpful until the pH had been raised to 9 or higher. This, because there was but little calcium in the water to form the protective coating desired. Experience with soft waters at several points had indicated as much. It appeared, then, that old mains should first be cleaned with a machine and further corrosion might be held in check by the chemical treatment to raise the pH value of the water.

C. W. Smedberg, Director of Public Works at Greensboro, agreed with this suggestion. He disclosed the effect of tuberculation of a 7-mile force main, at Greensboro, in reducing its capacity and the results from cleaning. He said, it was remarkable that a main of such length could be cleaned in only 4 hours' time and thereby returned to practically its original carrying capacity. The coefficient of this particular main, he said, had dropped from 120 to 80 before cleaning.

Another question concerned the effect of grounding electric circuits to household water piping. It was pointed out that such practice should be discontinued. Even the grounding of radios had been shown to be responsible for attack of brass fittings and water meters by electrolysis. In some cases the water had been made green by the copper dissolved from meters, not to mention destruction of the meter. In addition the electrolytic effect had been responsible for disagreeable metallic tastes and odors. It was, therefore, apparent that promiscuous grounding of electrical circuits through water pipes can create damage to services and meters and cause consumer complaints. Severing of these connections had corrected these difficulties and apparently proved the case.

Papers on Sewage Treatment

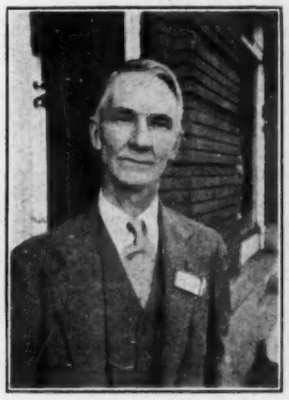
"Removal of Color from Textile Wastes with Ferric Chloride"—J. H. HENDERLITE, JR., Chemist, Sewage Treatment Works, Gastonia, N. C.

The author, being prevented from attending the meeting on account of illness, his paper was read by D. S. Abell of the State Department of Health.

Mr. Henderlite's paper recounted difficulties caused by dye wastes received at the Gastonia sewage treatment plant. The activated sludge process had not been capable of removing the dye and in addition bulking of sludge resulted. Suits for damages had been brought by riparian owners below the plant. Experiments conducted with ferric chloride as a precipitant added to the highly colored crude sewage entering the aeration tanks had shown the procedure beneficial to the activation process. The use of the iron coagulant produced a superior sludge and yielded an effluent practically void of color. Complaints of riparian owners had ceased.

The plant scale results had been superior to those indicated during operation of a small scale preliminary

C. E. Rhyne, Superintendent Water Works and Sewerage, Gastonia, N. C.



A. O. True, Sanitary, Engineer, Proximity Mills, Greensboro, N. C.

experiment. Crystal ferric chloride (60% $FeCl_3$) in dosages of 500 pounds per million gallons had been required during heavy run of dye wastes but fortunately the treatment was required only during about 7 to 8 hours each day and therefore the average cost per million gallons of sewage treated by the plant was between $3.10 and $3.47 with the lump ferric chloride costing $2.26 per hundred pounds. To avoid constant changing of chemical dosages with changing dye concentration the rate of application was maintained at a rate to care for peak conditions. An ordinary barrel with orifice had been used to feed a solution of 20 pounds of lump ferric chloride in 50 gallons of water.

The ferric chloride treatment had made the activated sludge process perform as it normally had without the dye waste present. "Bulking" had been prevented and comparative analyses of plant effluent had indicated the following averages over 15-day periods in July:

	No. Treatment	Ferric Chloride Coagulation
B.O.D. Influent	144	175
B.O.D. Effluent	46	25
Reductions	68%	86%
Suspended Solids (Inf.)..	183	238
Suspended Solids (Eff.)..	41	21
Reductions	78%	91%

A. O. TRUE, of the Proximity Mills, Greensboro, N. C., said that the results at Gastonia were very interesting and investigations of chemical treatment of textile wastes were to be conducted at Greensboro. They had found Indigo a particularly difficult dye to precipitate—even with ferric chloride.

H. F. DAVIS, of Charlotte, said that experiments with chlorination were under way at Durham in an attempt to decolorize dye wastes and ferric chloride had been used experimentally ahead of one of the Charlotte activated sludge plants with some benefit.

Sludge Conditioning and Filtration

"Conditioning Sewage Sludge for Dewatering"—L. L. HEDGEPETH, Engineer, Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.

Mr. Hedgepeth discussed the basic principles involved in coagulation of sewage sludges to free the solids from

Dr. G. P. Edwards, University of North Carolina, Chapel Hill, N. C.

P. W. Frisk, Chemist, American Enka Corp., Enka, N. C., Vice President of the Association

the water to procure free draining in vacuum filtration. The value of a rapid mix with the chemical involved, followed by a very short period of slow continuous mix, was emphasized. Filtration should be effected, he said, within 15 minutes after coagulant addition and the process of conditioning should be continuous. Ferric chloride had been the most effective conditioner used—with or without lime. When using lime the iron salt was applied first and thereafter the lime to raise the pH of the sludge liquor to 8.4 or higher.

Mr. Hedgepeth referred to the highly interesting and promising developments under way at Baltimore by C. E. Keefer and A. L. Genter in which the sludge was first washed, by adding water and decanting, prior to addition of the ferric chloride. Such treatment had increased filter yields by about 300 per cent and had reduced the chemical cost by about 50 per cent.

"Vacuum Filtration and Incineration as a Means of Sludge Disposal"—DR. G. P. EDWARDS, University of North Carolina, Chapel Hill, N. C.

Dr. Edwards, formerly chemist with the Sanitary District of Chicago and now Assistant Professor at the University of North Carolina, presented an up to the minute review of developments in filtration and incineration of sewage sludges.

In the larger plants sand bed drying, he said, was expensive and difficult—the greatest problem being what to do with activated sludge. In digestion of the latter, the problem of disposal of the large volume of supernatant digester liquor, was likewise a real problem. Furthermore, handling the viscous digested sludge was another serious problem, and the two had been responsible for increasing interest in vacuum filtration of the undigested sludge. The remarkable drop in the cost of ferric chloride had rendered it the most practical chemical for sludge condition because it produced the largest yields of solids per unit area of filter surface.

Dr. Edwards pointed out the increasing interest in dewatering digested sludges on vacuum filters. The thorough tests at Baltimore, Md., had indicated that it could be done at a cost less than required for sand bed operation, not to mention reduction in area required for dewatering.

In sludge dewatering with ferric salts, he thought the filter effluent (containing 25 to 35 per cent of the iron added to the sludge) should be returned to the incoming sewage or the aeration tanks at activated sludge plants with beneficial results. Iron, in reasonable amounts, seemed to be helpful to the activated sludge process rather than detrimental.

Incineration of dewatered crude or activated sludges had been receiving increasing interest since it had been realized that little if any fuel other than the organic matter in the sludge solids would be required. In the tests made at Chicago the wet filter cake, after drying to 20 per cent moisture content, had been burned without odor nuisance and with an inconsequental use of coal. As a result, a large plant for dewatering and incineration is planned to dispose of mixed crude solids and activated sludge at the West Side plant in Chicago.

The question of the desirability of providing for partial digestion of solids prior to filtration and incineration was open to argument. Admittedly the digestion tank served as a reservoir for solids which would increase the flxibility of plant operation but heat value would be lost in digestion and the overall cost might well be increased due to capitalization of the additional tanks required.

In summarizing, he said, that vacuum filtration of all sorts of sludges had been proven particularly, the cost ($5.00 per ton of dry solids) was approximately that of drying on sludge beds at the average plant whereas the area required and nuisance factor was far less. Sizable plants, equipped with sludge storage tanks or glass covers over filters, would find the cost of air drying higher than vacuum filtration.

L. H. ENSLOW, in discussion of the papers by Mr. Hedgepeth and Dr. Edwards, said that it was interesting to observe the trends in sewage treatment and compare these with the beginnings of water purification vs. modern practice. Water purification had started with large filtration areas dependent upon biological action but now the purification plants were mechanical and far smaller. Developments in the same general direction appeared to be taking place in sewage treatment.

The progress being made at Baltimore in sludge dewatering improvements is highly interesting and promising. If proven practical on a large scale, the cost of vacuum filtration of sludges will be far below that of sand bed drying. Nothing had been said concerning sludge conditioning at the smaller plants so frequently cramped for sludge bed area. The use of ferric salts at such plants had been very helpful in speeding up sludge dewatering and increasing the bed yields, not to mention the assistance in clearing the digestion compartment of accumulations resulting from a condition of "Nowhere to put the sludge if drawn."

Little had it been realized, that drying sludge on sand beds costs what it actually does. Published results in an article by D. F. Irvin in WATER WORKS AND SEWERAGE for November indicated actual costs at six important plants at representative locations over the country—all being well operated works where cost data was dependable.

THE 20TH ANNIVERSARY OF THE COMPLETION OF THE LOS ANGELES AQUEDUCT

ON November 5, 1933, the City of Los Angeles celebrated the twentieth anniversary of the completion of the Los Angeles Aqueduct; and many old time citizens, friends, and associates paid their respects to the grand old gentleman who had sufficient courage and foresight to undertake the task of transmitting water 250 miles across the desert and through mountains to a city, then, a very little larger than a Spanish pueblo.

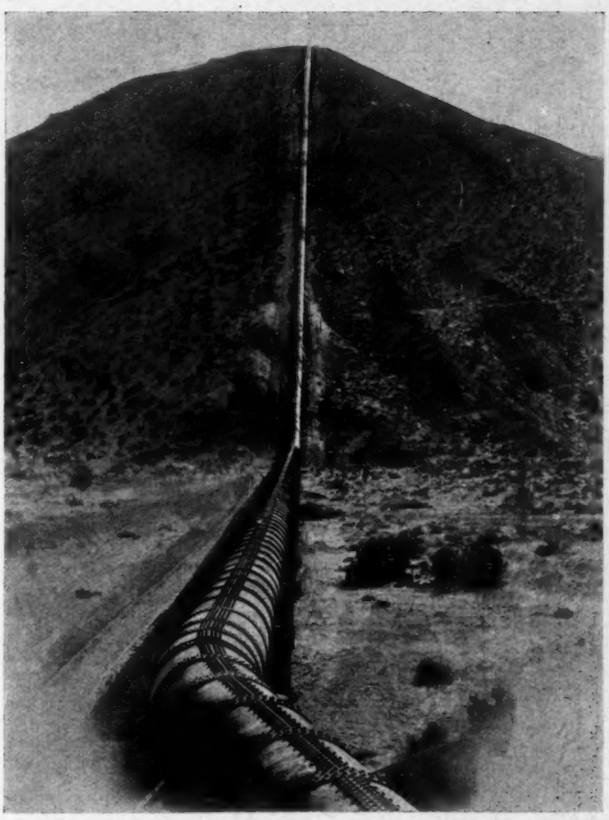
The City of Los Angeles is very proud of William Mulholland, Chief Engineer, designer and builder of the aqueduct, and rightly they should be because without his vision Los Angeles would not be the beautiful and progressive city that it is today.

In 1902 the city, with a population of 128,000, organized and put into operation its own municipally owned water works. The pipe in the system then amounted to 151 miles. Their single source of water supply was then the Los Angeles River, the waters of which are owned by the city in perpetuity.

In 1905 it became apparent to Mr. Mulholland, then chief engineer, that unless this supply was augmented from some source, the growth of the city would be permanently halted. The only available source of additional water of sufficient quantity and purity, were the waters from the melting mountain snows of the High Sierras, flowing down to the Owens River—and this water was 250 miles from Los Angeles.

In his customary thorough way, Mr. Mulholland immediately prepared plans and estimates for an aqueduct to bring the Owens River waters to Los Angeles. His estimate of cost of the project was approximately $25,000,000. This was one of the most daring engineering projects of the time, and the greatest municipal engineering project undertaken in that period.

It took a great deal of courage to face the small handful of people, then approximately 238,000, and place before them the prospect of increasing their debt obligation by voting $24,500,000 of bonds to finance the construction of this aqueduct. The people, however, indicated their faith in Mr. Mulholland's judgment by an overwhelming vote of better than 10 to 1 in favor of the project.



A Section of the Los Angeles Aqueduct Crossing the Desert —the Famous Jawbone Siphon. (Don't Be Deceived by Appearances of Distances and Dimensions on the Desert. A Small Motor Car Was Put Through the Pipe During Construction, to Allow "News Hawks" to Picture the Great Size of the Aqueduct.)

A Historic Occasion: Opening of the Intake Gates Delivering Owens Valley Water into the New System. (The Structure Was Christened by Mrs. H. A. Van Norman on Feb. 13, 1913; the Aqueduct Went into Service Nov. 5, 1913.)

Work was started in 1907 on what is officially known as the Los Angeles Aqueduct, and it was completed November 5, 1913, at a cost well under Mr. Mulholland's estimate.

Typical of the efficiency of the laboring and executive forces of Mr. Mulholland's organization, the project was completed ahead of schedule, and world records were established for the driving of rock tunnels.

The Los Angeles Aqueduct is the longest aqueduct in the world, consisting of 53 miles of tunnels, 12 miles of steel siphons, approximately 40 miles of exposed conduit, and approximately 145 miles of reinforced covered conduit. It has been in continuous service since its completion, delivering approximately 2,000,000,000 gallons of water daily.

During the 30 years that the city has operated its own municipal water works under the management of William Mulholland and the present chief engineer and general manager, H. A. Van Norman (Mr. Mulholland's

assistant during the construction of the aqueduct), the population of the city has increased from 128,000 in 1902 to better than 1,240,000 in 1933. The investment in the water system has increased from $2,000,000 in 1902 to over $139,000,000 in 1933.

The Los Angeles water system is one of the largest municipally owned water works systems in the world, and besides the aqueduct, consists of 3,788 miles of pipe ranging from 4 to 80 inches in diameter, 62 reservoirs and tanks, 38 pumping plants and booster stations, and some 329,000 services together with many other appurtenances that go to make up a water works system.

Price, Waterhouse and Company's audit as of June 30, 1933, shows a gross operating revenue of $9,452,391.70. After deducting maintenance and operation, depreciation of plant and equipment, interest on all General Water Works Bonds, and miscellaneous expenses, the net revenues amount to $1,545,247.51. In the face of both present and past economic conditions, this is a remarkable showing. The assets as reflected in the audit are $139,925,305.19, and the bonded debt is only $65,703,443.07—which is considerably less than half the assets.

Even though the system has operated at a slight profit ever since 1902, when it became municipally owned, the surplus earnings up to and including June 30, 1933, are $19,344,838.48.

William Mulholland, Builder of the Aqueduct

H. A. Van Norman, Chief Engineer and General Manager of the Water Bureau, Was Assistant Chief During the Construction of the Aqueduct

Acknowledgment.—For the above account and the loan of photographs used in illustrating it, we are indebted to W. W. Hurlbut, Engineer of Water Distribution, and E. B. Mayer, Assistant Engineer, Bureau of Water Supply, Los Angeles, Calif.

▼

British Rainfall

British Rainfall, 1932, published by H. M. S. O. (15s.) under the authority of the Meteorological Committee, is the seventy-second in the series, and contains a full account of the rainfall of the year under review, setting out the totals as recorded at over 5,300 stations. It includes maps, tables and descriptive matter showing the distribution of rainfall each month and for the whole year, and its relation to the average, studies of heavy falls on individual days of particular interest, discussions of heavy falls of rain in short periods, of the number of days with rain and of spells of dry or wet weather during the year.

CAST IRON PIPE USED IN LARGE SEWER CONSTRUCTION

By H. H. HENDON[1]
Sanitary Engineer, Birmingham, Ala.

JEFFERSON County was made a Sanitary District by an Act of the State Legislature in 1901, with the object of ridding streams of sewage and other pollution, entailing the building of main sewers from the various towns in the county to sewage treatment plants. Since that time, the twenty small towns then in the Birmingham District have been consolidated into the cities of Birmingham, Bessemer, Fairfield, Homewood and Tarrant, having a population of some 385,000. This district covers four drainage areas, that immediately south of the city of Birmingham is known as Shades Valley, being a very high class residential district with a population at present of approximately 10,000 and an area of approximately 20 square miles.

In 1928 the county built a main sewer to serve a part of this drainage area, and in 1932 decided to extend this 42-inch main approximately 3½ miles further up the valley. It being the policy of the county to take alternate bids on all recognized materials for construction work, for this extension, bids were called for on concrete pipe, 2-ring brick, monolithic concrete, segmental blocks and, in addition, a specially designed pipe of cast-iron. The low bids received on each material follow:

Concrete pipe	$109,370.00
2-Ring Brick	112,251.00
Segmental Blocks	120,279.00
Monolithic Concrete	121,055.00
Cast Iron Pipe	121,951.00

[1]Engineer in Charge of Sewerage and Sewage Treatment, Jefferson County, Ala.

The part of this sewer built in 1928, referred to above, was of concrete pipe, and for that part that was built below ground the water infiltration was some 40,000 gallons per mile per day. The 42-inch extension to this work runs parallel to and approximately 50 to 100 feet from a lake on one side and high ground on the other side, so the sewer is below ground for approximately its entire length. It therefore appeared doubtful that it would be possible to reduce the infiltration into this sewer much below 40,000 gallons per mile per day with the recognized sewer materials. On the basis of 30,000 gallons per day, per mile, for 3½ miles, the infiltration would be approximately 100,000 gallons per day. Since the stream into which this sewage will discharge is to date not polluted by any industrial or domestic wastes and is the source of several water supplies, the treatment of this sewage must be carried to a very high degree. For a small plant to provide such treatment the operating cost will approach $35 or $40 per million gallons, therefore the cost of treating the additional infiltration water would be approximately $1,500 per year. Assuming an interest rate of 5 per cent, the $12,500 difference between cast-iron pipe and concrete pipe represents approximately $600 per year, which is less than one-half of the cost of treating the additional water that could be expected from a sewer of concrete pipe. The nature of the ground and the permanency of material also favored the selection of cast-iron pipe.

Design Requirements of Cast-Iron Pipe Specified

Diameter	42.6 in.
Laying length	12 ft. 4 in.

Left: Water in Trench, Even With Lake Drained. Center: A Section of the Sewer, Showing the Neatness of Bells and Joints. Right: Reversing Practice—The Gravity 42 in. Cast Iron Sewer Passes Under a 42 in. High Pressure Water Main of Concrete Pipe

Weight	4,270 lbs.
Thickness of barrel	0.8 in.
Strength,—3-edge bearing	2,000 D. minimum
Tensile strength of metal	23,000 lbs. per sq. in.

[Results of Tests Made by Pittsburgh Testing Laboratories.]

Tensile strength, lbs. per sq. in.	30,740
Traverse Tests:	
Sizes of test pieces	26 in. by 2 in. by 1 in.
Distance between supports	24 in.
Deflection	.37 in.
Breaking strain	2,700 lbs.
Chemical Analysis:	
Silico	1.45 per cent
Sulphur	.079 per cent
Phosphorus	.75 per cent
Manganese	.58 per cent
Composition Test, 3-edge Bearing:	
Load in lbs.	8,160
Deflection in inches	2.45

This pipe is laid with poured cement joints, the mixture being one part Portland Cement and two parts clean, fine sand. About 8 hours after the joint was poured the runner was removed and the joint immediately painted with Inertol, which penetrated into the green grout, sealing the pores.

A Demonstration of Joint Tightness

During construction, about 500 feet of this pipe that had been laid was left uncovered at the close of the working day. That night the ditch became filled with rain water and since the water was dammed off from the upper end of the pipe, this section of pipe was completely submerged. Upon inspection, while the pipe was still submerged in the water, it was found that the whole section had floated slightly, being on grade at the two ends and up about six inches at the approximate center of the 500-foot section. With the pipe in this condition, there were no visible leaks through the joints. From the above experience, it is believed that there will be no trouble from the joints cracking from uneven settlement.

In taking this pipe up to re-lay it, the contractor would raise the end of the pipe with a crane and almost invariably this would raise two other joints of pipe, breaking at the third joint, thereby showing a surprising strength in the grout joints.

The Shades Valley Project. Special Light Weight Shallow Bell 42 in. Cast Iron Sewer Pipe Ready for Laying

On May 4th, 6,600 feet of completed sewer was tested for infiltration. The section was first thoroughly cleaned and then a small dam approximately 18 inches high was built in the lower end, with a V-notch weir in the top. The average of several measurements of water going over this weir was 3 gallons per minute. Practically all of this leakage was coming through the brickwork of 10 manholes, as there were absolutely no visible leaks through any of the cement mortar joints.

The above work was done by the County Commission

A Couple of Tough Spots on the Shades Valley Sewer

of Jefferson County, W. D. Bishop (President), W. E. Corning and R. E. Smith. The pipe was furnished by U. S. Cast Iron Pipe & Foundry Co. and the contractors were the Volz Construction Co. of Memphis, Tenn. The writer was responsible for design and supervision of construction of the project.

▼

"Vocational Guidance in Engineering Lines"

Reviewed by R. D. Rader, State Highway Engineer, Helena, Mont.

This book is sponsored by the American Association of Engineers and was edited by Dr. J. A. L. Waddell, assisted by Frank W. Skinner, Harold E. Wessman and others.

The publication of this book is undertaken on an absolutely altruistic basis, none of the authors or editors receiving any pay for their work. There are sixty chapters, each one dealing with some special branch of engineering and written by one of the leading specialists in that line. It is, therefore, the only authoritative book covering the subject of vocational guidance in engineering in existence.

The purpose of the book is to encourage the brightest, most active and most ambitious of the youth of the country to come into the engineering profession and to discourage those who are not fitted for this profession. It is not only of very great interest to engineers, but also to students of engineering and to those who contemplate entering a college engineering course. It is written frankly and honestly, with a view to placing before the engineering student the disadvantages of the profession, as well as its attractions and advantages.

This book should be read by every young man who contemplates the study of engineering and also by every engineering student. We believe that the reading of this book will save many flunk outs in college engineering courses, as well as prevent many misfits from entering the profession.

Vocational Guidance in Engineering Lines is published by the Mack Printing Company, Easton, Pennsylvania. Single copies postpaid $2.50 and in lots of 10 or more $2.00 per copy, including transportation.

REDUCING THE COST OF CHLORINATING

By C. H. VIVIAN
Phillipsburg, N. J.

BY introducing chlorine into sewage by recirculating a portion of the effluent to operate chlorinators, instead of using expensive tap water for the purpose, three New Jersey communities have materially reduced their water bills—and thereby the overall cost of chlorination. Their experience holds forth the possibility that other municipalities may make savings of a similar nature. This departure from conventional practice should prove particularly beneficial to those towns which do not own their water supply systems, or where there is a shortage of water.

Ocean Grove, Deal, and Long Branch, N. J., are the places where the new method was first successfully applied, and they adopted it in the order named. All three are seashore resorts in the Asbury Park area and all buy their water from a privately owned Water Company.

The disinfection of sewage is of primary importance in these popular shore resorts because the outfall lines empty into the ocean offshore from beaches where hundreds of thousands of persons bathe during the warm weather months. As is true of all communities of their kind, their populations fluctuate widely as between winter and summer and there are additional wide swings from week to week and from day to day during the bathing season itself.

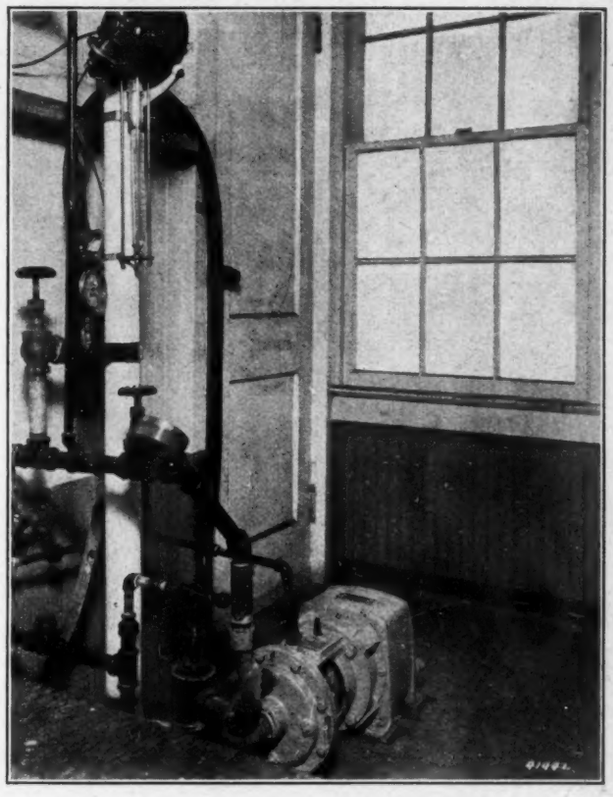
Large and sudden expansions in numbers of people greatly increase the demands upon the sewage disposal systems and require that facilities be provided and maintained which will prove ample during several months of the year to take care of the demands of from 10 to 50 times the normal permanent populations. Obviously, revenues cannot be commensurate with the scale of service for which provisions have been made and any economies that can be instituted in sewage treatment are accordingly of more than ordinary importance.

All three sewage disposal plants are of the sedimentation type and only the largest of the three, that at Long Branch, is equipped for mechanical clarification. Formerly, settlement and removal of the sludge was the only treatment accorded the sewage, but a few years ago the State Department of Health ruled that during the period of the year when the adjacent beaches are used for bathing, it should be supplemented by the use of chemicals. Accordingly, during the five months between May 15 and October 15 of each year, the sewage is chlorinated.

The chlorine is introduced by conventional methods, being fed from cylinders by standard mechanical chlorinators. In two of the three communities effluent is used to operate the injectors whereas tap water is still used to feed the trays of these vacuum type machines. In the other, sewage effluent is employed even for this service.

The Use of Effluent First Tried at Ocean Grove

The only additional equipment that had to be provided was a suitable pump and piping required for delivery of some of the effluent, under pressure, to the chlorinators. It was essential that the pump selected be reliable and it was of course desirable, in addition, that it be efficient, economical, and easy to install. A. J. Mount, operator of the Ocean Grove plant, who conceived the idea of using effluent for this purpose, selected for this service an Ingersoll-Rand (Cameron) "Motorpump," and thereafter the other two cities selected similar units when they adopted the scheme which had proven successful at Ocean Grove. This pump consists of a motor and pump built integral and with a common shaft, which makes for compactness and reduces the number of bearings to a minimum.



At Ocean Grove, N. J.—The First Installation in New Jersey to Utilize Sewage Effluent for Chlorinator Operation.

The Ocean Grove plant handles an average of about 400,000 gallons of sewage daily, although, as previously mentioned, the quantity shows wide variations. The chlorination chamber is in the form of a series of connected parallel concrete channels and are located underground beneath a section of the boardwalk along the waterfront. The period of detention of sewage in these channels is from 20 to 30 minutes. The chlorine is introduced by means of a Paradon manually controlled chlorinator.

At a point just short of the weir over which the effluent discharges, a portion of it is taken out for operating the chlorinators. As the pump is housed 15 feet higher, this imposes a suction lift of that distance, but the pump performs satisfactorily under this condition. The effluent is three feet deep in the contact chamber and the suction line is submerged to within about eight inches of the bottom.

The pump is a size 1-ORV and is rated at 20 g.p.m. against a head of 100 feet. It is driven by a General Electric 1½-hp. (3,500 r.p.m.) motor.

The water rate at Ocean Grove is on a sliding scale, the range being from 30 cents per 100 cu. ft. down to 20 cents until 65,000 cu. ft. have been used, after which the same scale is repeated. During the five months that chlorination was practiced, the plant used an average of

22,700 gallons of water a day. The cost was $772. By using effluent for all purposes except supplying the chlorinator tray, the water bill was reduced to $9 during the next five-month period of chlorination. Current for operating the pump cost $105. As the installed cost of the pump was $160, it saved its first cost and operating cost nearly twice over during the first season of use. Maintenance and repairs totaled less than $2 during the five months, even though the unit was in service almost constantly.

The Deal Installation

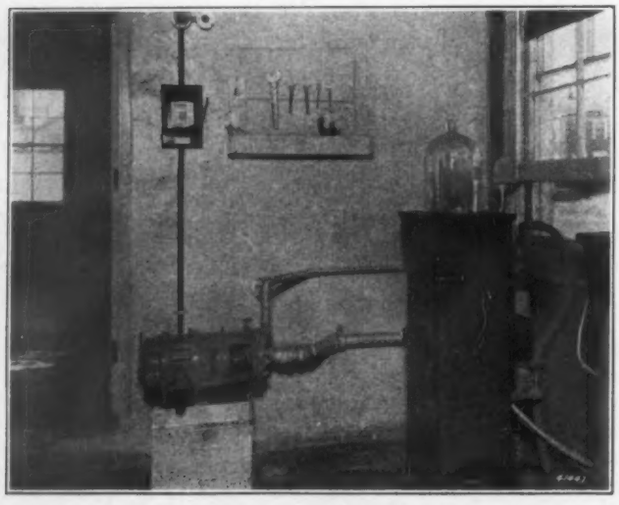
The plant at Deal is generally similar to that at Ocean Grove. Here, also the treatment structures are all located underground. Incoming sewage goes to a wet well, from which it is pumped to the settling basins. The pump for this purpose cuts in automatically when the sewage rises to a certain level. The plant handles up to 800,000 or 900,000 gallons of sewage daily during the summer season, the average being around 600,000 gallons.

Chlorine is dosed by one of two Wallace & Tiernan vacuum type machines. The effluent suction line to the chlorination "motor pump" consists of 200 feet of 2-inch line and the pump suction is under a head of 18 inches. The pump is of the same type as that used at Ocean Grove, but is slightly larger in size. Its present capacity is 20 g.p.m. against a head of 100 feet and it is driven by a General Electric 2-hp. (3,490 r.p.m.) motor. A small impeller is installed now, but by replacing it with a larger one, the capacity of the pump can be increased so that it will serve both chlorinators if it later becomes necessary to use them simultaneously.

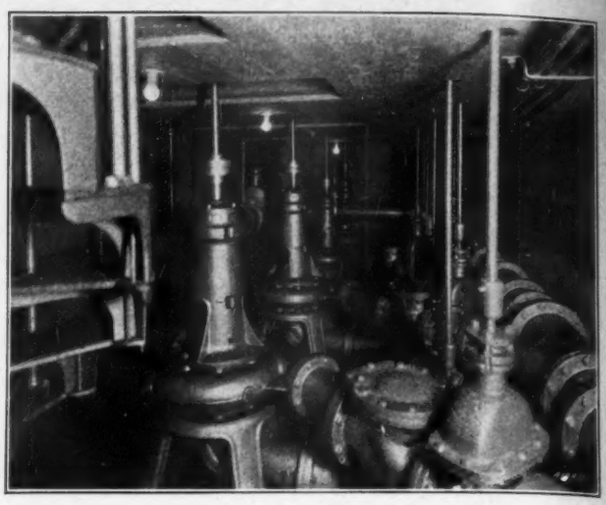
Before the new arrangement was adopted, the plant used about $625 worth of water during the 5-month chlorination period. It is expected that practically all this charge will now be eliminated.

The Long Branch Installation

The Long Branch plant is larger than the other two described and differs from them also in that it is operated by a private company, the Long Branch Sewer Company. This organization has been functioning nearly 50 years and has progressively improved and extended its facilities as the growth of the city required. It serves about five square miles of territory through 50 miles of sewer lines. The plant is located at the lowest point in the city, so that all sewage flows to the plant by gravity.



At Long Branch, N. J.—Ingersoll-Rand Motor Pumps Connected to Wallace &Tiernan Chlorinators. If the Pump Stops Nothing Happens Because the Chlorinator Automatically Stops the Flow of Chlorine Gas.



Crude Sewage Pumps, Long Branch, N. J. (Beneath the Boardwalk). F. M. Pumps 400, 700, and 1,000 G.P.M. Deliver to Dorr Clarifiers.

Incoming sewage is registered by a Simplex meter and goes to a wet well, from which it is pumped by any one or more of four Fairbanks-Morse vertically disposed electric-driven units. In gallons per minute, these pumps have capacities of 400, 700, 1,000 and 1,000, respectively. A 14-inch line extends from the wet well to the two sedimentation tanks of concrete construction, each being 50 feet square and 14 feet deep and having a capacity of 350,000 gallons. They are fitted with Dorr traction-type clarifiers. At 4-hour intervals, the sludge is pumped to adjacent digestion tanks, from which the gases escape to atmosphere through a 75-foot hollow steel flagpole.

Two Wallace & Tiernan vacuum type chlorinators are installed, one being used at a time. The effluent recirculating pump is a Cameron 1-RV-2 rated at 40 g.p.m. against a 98-foot head. It is driven by a G.E. 2-hp. (3,490 r.p.m.) motor. Figures on a full season's operation are not yet available, but it is estimated by William J. Emmons, Manager of the Company and Chief Operator of the plant, that the water bill has been cut at least 75 per cent by the change over to the use of plant effluent instead of fresh water.

The Long Branch plant handles an average of 1,500,000 gallons of sewage per day, which differs somewhat in character from that at Ocean Grove and Deal, in that it contains considerable quantities of industrial waste.

From the above experiences it is evident that the cost of sewage chlorination can be materially reduced in many instances by the practice of utilizing plant effluent in place of the community water supply for operating the chlorination equipment. Furthermore, the scheme has been proven entirely practical.

▼

PUBLIC POTABLE WATER SUPPLIES DEFINED.—The State Department of Health of New Jersey by a resolution adopted Dec. 6, 1932, defined "public potable water supplies" as those supplies from which water is distributed or sold to consumers for potable purposes in eight or more dwellings or properties. Water from sources of supply which is distributed or sold to less than eight dwellings or properties will hereafter be considered as private sources of supply and under the jurisdiction of the local health board.

METHODS FOR THE AERATION OF SEWAGE

By HAROLD E. BABBITT
Professor of Sanitary Engineering, University of Illinois

DIFFUSION of air in fine bubbles through the sewage in an aeration tank is now the most widely accepted method for the aeration of sewage in the activated sludge process as practiced in the United States. It has been the accepted standard method since the completion of the pioneer tests at Milwaukee and the corroborative tests at Chicago. Both in Europe and the Orient mechanical methods of agitation are used extensively and with satisfaction. Some tests on mechanical agitators have been made in this country and a number of small plants have been equipped with mechanical aeration devices. That either air diffusion or some particular method of mechanical agitation is the best method is, therefore, open to discussion. It might be well, then, to look searchingly at the various methods for the aeration of sewage to see what the future may bring forth.

Diffusion of air involves the blowing of bubbles through a submerged, porous medium, breaking the stream of air into finely divided bubbles as it rises through the sewage. It requires considerable equipment for compressing the air, for cleaning the air in order to avoid clogging the porous distributors, for distributing the air to the diffusers, and it involves an appreciable cost for power and maintenance. It can be relied upon to produce satisfactory results in the treatment of sewage under proper conditions.

Mechanical methods of sewage aeration, sometimes known as bio-aeration methods, include the Sheffield paddles which revolve on horizontal axes and the Hartley paddles which revolve on inclined axes and agitate the surface of the sewage; the Simplex revolving head which agitates the surface of the sewage and turns over the contents of the tank; the Watsco aerator and the Aeromix, which mix air with the sewage by aspiration as the sewage passes through a constricted down-draft tube; the Jones propeller which is operated from a float and agitates the surface of the sewage; the Link Belt mechanical aerator which imparts a spiral flow to the liquid by means of a longitudinal paddle which agitates the surface of the liquid and moves it transverse to its direction of flow through the aeration tank; the American Well Works equipment which operates on a principle similar to the Watsco and the Aeromix aerators; and a method, sometimes atributed to Imhoff but probably used by others prior to Imhoff's installation at Essen-Rellinghausen, involves the stirring of the sewage with submerged paddles while a small amount of air is diffused through the porous medium in the bottom of the tank. Both air diffusion and mechanical agitation involve the use of proprietary devices and require the presence of a skilled operator.

Bio-aeration, as applied to methods of aeration involving the use of mechanical devices is a misnomer as it should refer to all forms of aeration. Technical language seems to be leaning towards the use of this term to apply to mechanical aeration only in spite of the fact that the term, in its origin, referred to all methods for the aeration of sawage.

Development of Methods of Aeration

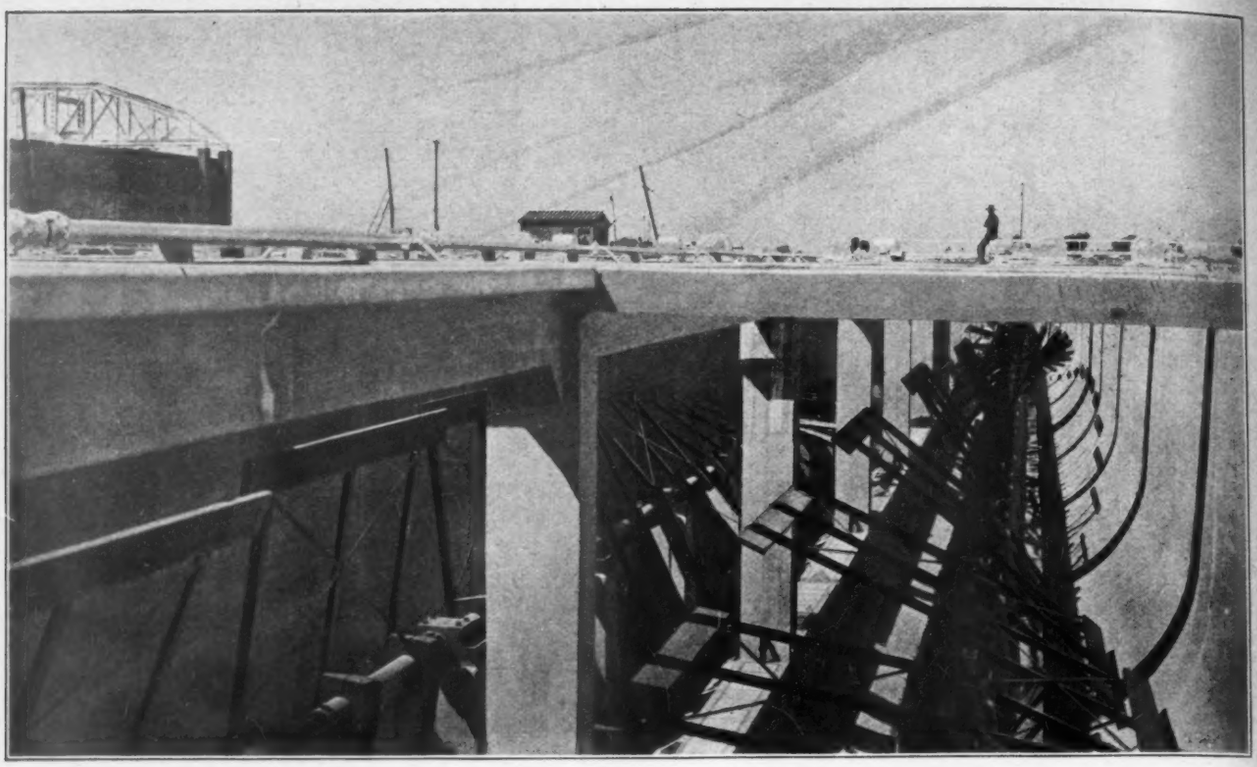
An early theory of the aeration of sewage was to the effect that air must come into intimate contact with the sewage for an appreciable period of time. This seemed to be accomplished best by the formation of small, finely-divided bubbles, which gave a greater surface of contact between the oxygen and the sewage, and by holding these bubbles in contact with the sewage for the longest possible time. To gain this effect, deep tanks were built in order that the bubbles might have a long column of liquid through which to rise. Spiral flow tanks were developed in order to force the air downward with descending stream of sewage as well as rising with an ascending stream. The limit of depth of air-diffusion aeration tanks was fixed only by the added cost of compressing the air. Among the deepest air-diffusion aeration tanks were those at Reading, England. The process proved ineffective as the added time of contact between the bubbles and the sewage did not give the improved results anticipated. This apparent paradox has been borne out by subsequent experience with mechanical aeration devices.

In the mechanical agitation of sewage with paddle wheels or other forms of surface agitation there is no method of measuring the amount of air absorbed by the sewage nor of the period of contact between the atmosphere and any particle of sewage. Just how the aeration occurs or the absorption of oxygen is effected is uncertain. In the diffusion of air through sewage it has been found necessary to mix one cubic foot, or more, of air with each gallon of sewage; a ratio of volumes of one of sewage to at least seven and a half of air. Two methods of mechanical agitation have made it possible to study somewhat the amount of air required through surface agitation. Imhoff claims to have made activated sludge successfully (Engineering News-Record, Aug. 19, 1926, p. 299) at Essen-Rellinghausen with a ratio of one volume of sewage to one volume of air, and an aspirator mechanism is reported as able to function successfully with one-fourth to one-half this amount of air to one volume of sewage.

What is the reason for this? Why is more air required in air diffusion methods of aeration than in mechanical agitation? One possible answer is that some of the air supplied in air diffusion methods is used only for agitation. If it is the stirring of the sewage which effects the aeration, then mechanical means of stirring, possibly supplemented with diffused air, should be more effective.

Advantages and Disadvantages of the Two Aeration Processes

Mechanical agitation seems to overcome some of the objections to air diffusion in that there is no need for expensive air compression equipment, no air piping is needed, air filters are not required, and the power consumption is reduced. An objection to mechanical agitation is the longer period of aeration which it is supposed the method may require. Some authorities have contended that the period of aeration in mechanical agitation may be fifty to one hundred per cent longer than that required in air diffusion tanks. This has not been entirely borne out in practice. The impression was probably gained from the long period of aeration required



Phoenix, Ariz.: Dorrco Duplex Aerator—Revolving Paddles and Diffused Air in Combination. Developed by Dr. Imhoff to Reduce Aeration Costs.

with the strong, industrial sewage at Sheffield, England, where the paddle form of agitation originated. The aeration period there may be between ten and fifteen hours. With such weak sewages as are found at Princeton, Ill., a period of eight hours with Simplex mechanical agitators is found to be satisfactory. The Hartley aerators at Birmingham, England (providing partial purification) hold the sewage only one hour, and at Essen-Rellinghausen, Imhoff obtains complete treatment with a 3½-hour aeration period when employing a combination of paddles and diffused air. The idea that a longer period of aeration is required by mechanical agitation is not borne out in practice.

An objection to the use of aerators of the Sheffield or Hartley types is the shallow depth of tank which must be used. This results in the occupation of a larger ground area, for the same period of retention, than is required by deeper tanks. In some rare instances a shallow depth of tank may be desirable because of high ground water or expensive rock excavation. The initial cost of aerating tanks with large surface area may be greater than for deeper tanks but the cost of operation will not increase with increase of area. The difficulty of excessive area requirements and shallow tanks is inherent only in the unsubmerged (English) paddle wheel type of mechanical aerators. Relative areas required by different methods of agitation cannot be stated precisely because of differences in the quality of sewages at different places where tests have been made.

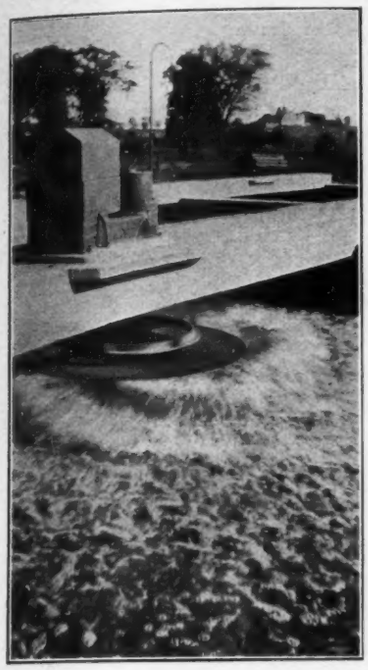
Ice may threaten difficulties to some forms of mechanical agitators. Unsubmerged paddles, when not covered, will produce ice at a rapid rate when the temperature of the atmosphere is at the frost line and it is not quite cold enough to form ice on quiescent bodies of water. It is unsafe to operate uncovered paddle wheels in frosty weather without constant supervision as the paddles must be stopped at the first sign of trouble. The difficulty arises because the uncovered wheels create a fine spray which quickly cakes the wheel and its surroundings with ice. The difficulty can be overcome by housing the paddles. In England and Japan, where these wheels are in use, the weather may be cold for long periods of time but no ice troubles are reported because of the housing over the wheels. Deeper tanks, with other methods of agitation, have operated successfully through rigorous winters in the United States and in England. No plant depending on aspiration for aeration has yet been installed where frost troubles have been encountered but the nature of the equipment is such that there should be no difficulty from ice because there need be no moving parts located in unprotected places and the surface of the sewage is not broken into a spray.

Sedimentation in Aeration Tank Not Serious

In the operation of an air-diffusion aeration tank it is generally considered undesirable to allow the air to stop flowing while there is sewage in the tank as sedimentation may occur which will clog the air diffusers, making it difficult to start up again. The cleaning of the air diffusers, once clogged, is an arduous and expensive task which may hold the unit out of service for an appreciable period of time. No such difficulties are encountered with mechanical agitators. Sedimentation may occur in the aeration tanks if the agitators are stopped temporarily but the tank is quickly stirred up again when the agitators are started. Deposits may occur in quiet corners of improperly designed shallow tanks but in the deep tanks called for by some types of aerators no deposits occur during operation because the contents of the task are being constantly turned over from top to bottom.

Amount of Return Sludge.—Return sludge is an important factor in the successful operation of an activated sludge plant and the amount to be cared for in design should be known with precision. In reports on existing plants there is ambiguity in the form of the reports. One will read: "We are operating successfully with only twenty percent of return sludge," or possibly "During the excessive load from the . . . industrial plant it was

found necessary to return as much as forty per cent of sludge." Two uncertainties arise in the mind of the reader: first, does the percentage refer to the mixed liquor or to the raw sewage; and second, how much dry solids is there in the return sludge? The dry solids in the activated sludge represent the constituent which does the work in seeding the raw sewage. No work is done by the liquid in the sludge. Hence, twice as much sludge containing one per cent dry solids (99 per cent moisture) must be recirculated as of sludge containing two per cent dry solids (98 per cent moisture). Most reports refer to the percentage of dry solids, in the return sludge but where the percentage of moisture or solids in the return sludge is not specifically stated there is little value of mentioning the volume of the return sludge.

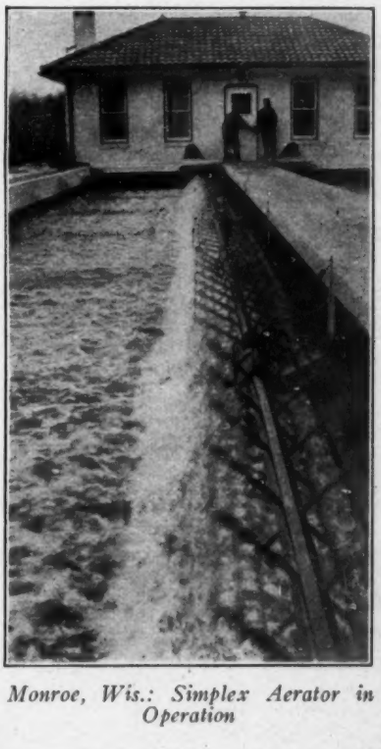


New Canaan, Conn.: Aeration Supplied by Link Belt Co. "Straight Line" Mechanical Aerator

A comparison of the reports of the operation of mechanical agitation plants shows that a smaller amount of sludge is returned than is customary practice at air diffusion plants. At Sheffield, England, 15 to 20 per cent return sludge is used; at Bury, England, 10 to 11 per cent; at Princeton, Ill., 18 per cent; at Essen, Germany, 8 per cent; and at Birmingham, 2 to 5 per cent; whereas air diffusion plants report 10 to 35 per cent return sludge. The reasons for successful operation with less return sludge in mechanical aeration tanks is not immediately apparent. It is possible that with equally good results on the same sewage equal amounts of return sludge would be required for either process. If it could be shown, however, that some particular method of aeration requires less return sludge than another method, it would be a factor favorable to that particular method of treatment. The volume of return sludge represents a large item in pumping and sludge handling costs at any plant. For example, in the early operating records at the North Side Plant at Houston, Texas, it was reported that 90 per cent of the suspended solids, originally amounting to 310 p.p.m. were removed by the activated sludge process. If these all appeared in the activated sludge, containing 98 per cent moisture, there were 13,800 gallons of excess sludge handled per million gallons of sewage treated. If the mixed liquor contains 25 per cent of return sludge with 98 per cent moisture then the volume of return sludge to be handled will be 330,000 gallons per million gallons of sewage treated, or 24 times as much return sludge as excess sludge to be removed from the process. This represents an appreciable item in the cost of the operation of the plant.

If perchance the aeration is poor, as is often the condition and the sludge contains only one per cent instead of two per cent of solids, then the amount of return sludge must be doubled and the aeration period is proportionately shortened. It is a vicious cycle for the shortened aeration period may result in further underaeration of the sludge, finally resulting in the undesirable effect of sludge bulking, which may be difficult to overcome For example, let it be supposed that aeration tanks have been designed to provide a period of aeration of six hours, for one million gallons of sewage to be treated daily, including return sludge containing 98 per cent of moisture, representing twenty per cent of the mixed liquor. The volume of the tank, computed by displacement, will be 292,000 gallons. If, due to underaeration, or other causes, the percentage of moisture of the return sludge is increased to 99 per cent, so that double the amount of sludge must be returned, the aeration period of the mixed liquor, containing one million gallons per day of fresh sewage, will be reduced to 5 hours and 15 minutes, which may further aggravate the underaeration of the sludge.

Control of Operation.—Difficulties of underaeration can sometimes be partly or entirely overcome by increasing the amount of air delivered to air-diffusion aeration tanks or by increasing the speed of the moving parts in mechanical agitation tanks, provided the air compressors or the electric motors are equipped for speed regulation or overload operation. Shallow aeration tanks, if properly designed for depth of flow, provide easy control of the period of retention which is not possible in deeper tanks. An increase of depth of flow from four feet to six feet will increase the period of aeration by fifty per cent. An equal increase of 2 feet in the depth of flow in a 15-ft. tank will increase the period of aeration only 13 per cent.



Monroe, Wis.: Simplex Aerator in Operation

Absorption of Oxygen.—An explanation of the rapid absorption of oxygen which occurs in mechanically operated plants is that the thin film of sewage which is exposed to the atmosphere at the surface of the liquid becomes saturated with oxygen almost instantaneously. This saturated film forms an insulation against further absorption of atmospheric oxygen which, in a quiescent body of water, must diffuse slowly through the liquid, penetrating a constantly thickening layer of saturated liquor. If the saturated stratum at the surface can be broken up, and the body of liquid turned over, a constantly changing stratum of underaerated liquor is exposed to the atmosphere to become saturated with oxygen, then to become mixed with underaerated liquor within the body of the tank. This occurs in both mechanical agitation and air diffusion. The turning over of the tank contents with successive exposure of the strata of the liquid to the atmosphere seems an essential factor in successful aeration regardless of the method of accomplishment. This is borne out by the relatively

greater success of spiral-flow diffused-air tanks as compared to those having even distribution of air over the horizontal area of the tank. It is also borne out by the almost equal success in diffused-air aeration in shallow and in deep tanks; the sole advantage of the deeper tank, for equal surface of exposure, being the longer period of aeration. It is evident, therefore, that in air diffusion tanks, much of the power is utilized in turning over the contents of the tank. This power can be applied more efficiently by mechanical means than through air bubbles. It is possibly for this reason that mechanical aeration devices are frequently reported as consuming less power per million gallons of sewage treated. It explains the remarkably low power consumption claimed by Imhoff for his submerged paddles combined with air diffusion.

If the greatest amount of aeration occurs at the surface of the liquid in contact with the atmosphere the advantage of small, and widely diffused air bubbles is open to question. The original tests on air diffusion were conducted in non-spiral flow tanks. The air was evenly distributed over the entire area of the tank. Under such conditions the more finely divided the bubbles the more rapid the turn over of the tank contents, as large bubbles will slip through the liquid more rapidly without lifting it to the surface. However, with off-center location of air diffusers it is possible to secure satisfactory aeration by the use of larger air bubbles, thus doing away with the difficulties of maintenance and head losses encountered in fine grained diffusers. Modern practice is decidedly in this direction.

Determination of the amount of oxygen absorbed from the rising bubbles of air in diffusion tanks has been made by collecting the air after rising through the sewage and analyzing it for the oxygen content. Some experimenters have reported as much as thirty per cent deficiency of oxygen, indicating that the efficiency of the absorption of oxygen from the rising bubbles is good. In this connection Imhoff's submerged paddle aeration device at Essen-Rellinghausen offers an unusual opportunity for comparing mechanical or surface aeration with air diffusion, since the tanks are so constructed that satisfactory action can be obtained by either method of aeration. Imhoff reports that with diffused air alone 0.7 to 1.0 cu. ft. of air was required per gallon of sewage treated, but when the mechanical agitation was started only 0.14 cu. ft. of air was required per gallon of sewage, indicating a high rate of absorption at the surface.

Mechanization of Sewage Treatment.—Operation of sewage treatment plants has been greatly improved in recent years through the installation of mechanical devices which have required the continual presence of operators. During the days of the popularity of the septic tank, when it was believed that the tanks could be constructed, buried, and forgotten, sewage treatment was marked by neglect and failure. Conditions have changed and sewage treatment plant designers can point with pride to the results being obtained with full-time operators in control.

Aeration by diffused air or by mechanical agitators requires considerable mechanical equipment and the presence of a skilled operator, assuring care of the sewage treatment plant and offering a promising portent for the future in sewage treatment, whatever type of agitation may be adopted for aeration.

▼

A Correction

In an article, which appeared in our December issue, describing the new filtration plant of Fort Wayne, Ind., there is an error in the list of manufacturers supplying various materials and equipment. "Meters and Gauges" should have been credited to Simplex Valve and Meter Company of Philadelphia, Pa. The error (faulty proofreading) was ours and not the author's.

▼

NRA—Releases of Information Covering Loans and Grants to Cities for Water Works and Sewerage Projects*

(Release No. 14)

Location and Project	Loan-Grant	Amount
Shippensburg, Pa., intake, chlorinator, supply main	G	$36,000
Ann Arbor, Mich., trunk sewer and disposal plant	L and G	450,000
Anna, Ill., wells, pumping and softening equipment	L and G	110,000
Mandan, N. D., reservoir	L and G	49,000
Girard, Ill., tank, pumping equipment, force main	L and G	109,000
Rome, Ga., sanitary sewer	L and G	130,000
Rome, Ga., filtration plant, pumping equipment	L and G	230,000
Providence, R. I., settling tank, aeration tanks, compresses	L and G	475,000
Virden, Ill., waterworks system	L and G	188,000
Genessee, Kans., waterworks system	L and G	49,000
Divernon, Ill., waterworks system	L and G	63,000
Stamps, Ark., well, pump station, tank, distribution	L and G	42,000
Roseville, Ill., well, pumping equipment, tank	L and G	12,000
Westchester County, N. Y., intercepting sewer	L and G	2,100,000
Montevideo, Minn., sewer and treatment plant	L and G	73,000
Worcester, Mass., water main	L and G	139,000
Longview, Texas, treatment plant and sewer	L and G	42,000
Selmer, Tenn., waterworks system	L and G	92,000
Rochester, N. Y., sewer system (extension)	L and G	660,000
Lexington, Mass., water mains, tank	G	11,000
Cheviot, O., trunk sewer	G	7,700
Santa Cruz, Calif., tank, mains	G	23,000
Hanapepe and Kapaa, Hawaii, T. H., cast iron main	G	21,300
San Louis Obispo, Calif., sewers, additions to sewage plant	G	9,000
Stillwater, Okla., sewer	G	4,000
Onondaga County, N. Y., intercepting sewer, sewage treatment plant, pumping station	L and G	1,650,000
Temple, Texas, water tank	G	15,000
Antioch, Ill., water tank	G	3,000

*Releases 1 through 9 appeared in the November issue; 10 through 13 in the December issue of Water Works & Sewerage.

▼

Reading to Go Forward with Large Water Project

An Engineering Board of Review consisting of G. Gale Dixon of Youngstown, Ohio, C. A. Emerson, Jr., of New York City, and Farly Gannett of Harrisburg, Pa., recently reported (Dec. 14, 1933) to the Mayor and Council of Reading, Pa., on the comprehensive program of water works improvements proposed by A. R. O'Reilly, Chief Engineer of the Bureau of Water of that city.

The essential features of the program have been approved and the preparation of details will proceed at once, as the funds needed for the project, which will run about $2,500,000 in total cost, are already available through authorized bond issues and Federal grant. The work includes the raising of Ontelaunee Dam to form an impounding reservoir of 3.88 billion gallons content, the construction of an outlet tunnel and 60-inch raw water supply conduit, a complete new rapid sand filter plant with capacity of 20 million gallons daily, a covered reinforced concrete reservoir of 30 million gallons content, and a 2 million gallon steel standpipe.

TASTES, CHLORINE AND CHLORAMINES IN WATER PURIFICATION—Part II

By CHAS. H. CAPEN, JR.
Consulting Engineer, East Orange, N. J.

THE observations and conclusions given in an earlier article, which appeared in WATER WORKS AND SEWERAGE for December, 1933, were largely the result of general conclusions drawn from experiences gained over a period of years. In this supplementary article a specific instance will be cited to substantiate some of the statements made in the first, particularly in reference to the relation of the chlorine dose to water temperature and the benefits of chlorine treatment. A brief case history of the supply to be discussed is herein given.

The water supply of the city of Orange, N. J., has been obtained chiefly from a surface source since 1883. In 1914 filtration was recommended but chlorination was adopted as a less expensive substitute. Results during the first few years of chlorination of this water supply, varying widely and rapidly in chlorine demand, were only partially satisfactory. Tastes resulted at times, particularly in the winter. Increasing attention to bacterial quality led to the installation of a second point of chlorination in 1927 (See Fig. 1). This was for the purpose of maintaining a residual in the mains to prevent aftergrowths.

In July, 1929, a pressure filter plant was installed. Local conditions made the use of a coagulation basin almost prohibitive in cost. After initial experiments, the process as adopted consisted of chlorination, slum treatment, pumping (using the mixing action of existing pumps as an aid to floc formation) pressure filtration, soda ash treatment for the correction of pH value, storage in the distribution reservoir and chlorination at the outlet end of the latter. This second point of chlorination was discontinued at the end of 1929 when the advent of the first low temperature filtered water showed that no entirely effective dose of chlorine could be added at that point without producing tastes.

In 1930 it was found that even the utmost degree of care exercised at the plant could not insure the delivery of a water to consumers' taps which contained no B. Coli and at the same time would be free from chlorinous tastes. This condition existed principally in cold weather.

The development of the automatic residual chlorinator was attracting attention at this time and on January 6, 1931, one of these machines was installed at the plant. At first the machine was controlled by the residual in the filter effluent line although the application of chlorine occurred at the filter inlet. The control apparatus worked as designed but the time lag between the two points was one-half hour and it was found that an almost perfect sine curve of under and over chlorination resulted with the nodes one-half hour apart.

Water sampling from the top of the filters (applied water) was then taken for the control. Some almost perfect charts resulted at times although the mechanical difficulties of the machine were frequently troublesome. The disadvantages of this method was that the chlorine absorption in the filters varied considerably and the residual in the filter effluent held no constant relationship to that in the applied water. On July 8, 1931, the machine was discontinued.

Ammoniation Tried

The use of ammonia was then advocated but it was not until the end of December, 1931, when conditions in the water indicated that complaints of taste might soon be expected, that authorization was procured to install an ammoniator. At that time the water had an unusually high chlorine demand, which coming simultaneously with the low chlorine assimilation value of cold water, made it obvious that the normal chlorination process would not be satisfactory and the ammoniator was installed on a trial basis. The accompanying graph (Fig. 2) pictures what happened during the first month of operation, particularly with respect to cost.

At first the chlorine was kept at nearly the same point as when used alone. With chlorine at 5½ cents per pound and ammonia at 14 cents, the cost was obviously much higher. It took one or two days for the filters to become divested of the excess organic matter that was not oxidized when chlorine alone was used, and another day or two for the ammonia-chlorine treated water to permeate the distribution system. To produce the same bacteriological results, less and less chlorine progressively was required. The graph (Fig. 2) shows just how far this was carried. It must be noted, however, that the critical point, at which chlorine demand drops, occurred almost simultaneously with the introduction of ammonia so that only part of the actual saving in chlorine cost can be attributed to the latter. It should be explained that slight daily variations in chlorine and ammonia have been omitted from Figs. 2, 3, 4 and 5 so as to simplify the diagrams.

Tastes of chlorine or chlorinous products at the consumers' taps ceased almost immediately after starting the use of ammonia and other tastes seemed also to have

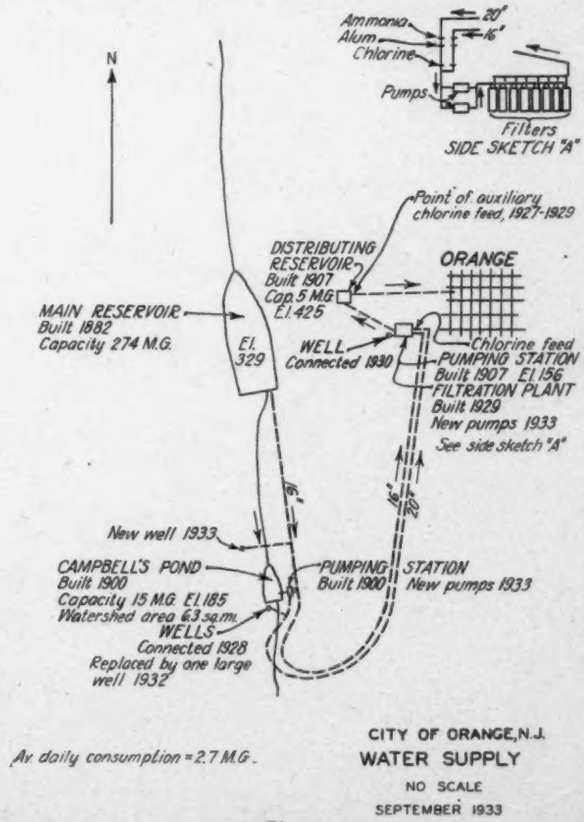


Fig. 1

been reduced. However the process was looked upon mainly as an expedient for preventing cold weather tastes. When it was found that during July, 1932, the chlorine consumption was almost equal to that of the preceding July and that the ammonia was adding extra cost, its use was discontinued on August 7, 1932. A slight increase in chlorine was soon found necessary. Very shortly thereafter mild complaints began to come in, although it was almost impossible to detect any difference in the taste or odor of the water leaving the

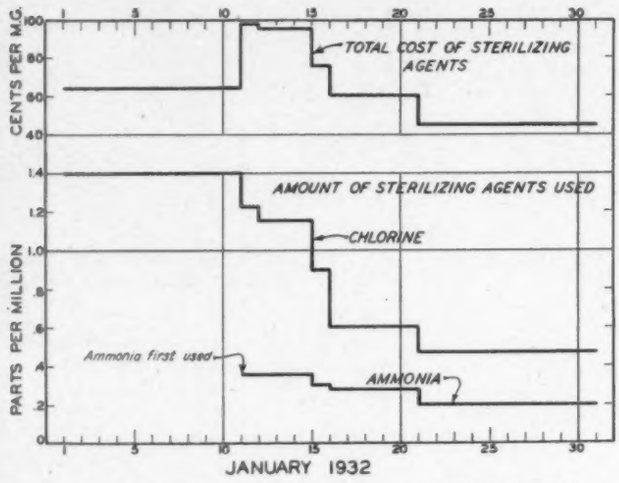

CENTS PER M.G.
TOTAL COST OF STERILIZING AGENTS
AMOUNT OF STERILIZING AGENTS USED
CHLORINE
Ammonia first used
AMMONIA
PARTS PER MILLION
JANUARY 1932
Note. Use of ammonia partly coincided with occurrence of critical temperature resulting in greater reduction in chlorine than would normally be expected.

Fig. 2

plant. On August 30, 1932, ammonia was again added and within a short time complaints ceased. (See Fig. 3.)

Effect of Ammoniation on Chlorine Consumption

A comparison of Figs. 2 and 3 shows the relative effect of ammonia on chlorine consumption in cold weather and warm weather. An intermediate temperature zone effect is shown in Fig. 4 which demonstrates the conditions during the month of May, 1933, when the ammonia had to be shut off during some alterations at the filter plant and pumping station.

Figure 5 has been drawn to demonstrate the conditions occurring when the critical temperature point is reached. While a fairly substantial reduction in sterilizing agents was possible before the critical temperature was reached, the largest individual reduction took place exactly when the temperature changed from 43 to 42 degrees.

Going a little more specifically into the matter of tastes, it has been observed in the winter when tastes are most troublesome, that when chlorine alone was used the filtered water often gave a decided odor of chlorine but only a slight taste. This condition changed during the passage of the water through the distributing reservoir and mains with the result that there could be noticed only a very slight musty odor but a rather pronounced chloro taste. With the ammonia-chlorine treatment the filtered water gave a slight chloro odor and a typical grassy taste while the water at the consumers' taps had practically no odor and a very slight earthy taste.

When chlorine is added prior to filtration, a large reduction in residual takes place within the filters due to the avidity with which the chlorine attacks the stored solid material retained by the sand. Peculiarly enough, chloramines, in contrast to chlorine alone, frequently show a lower residual in the applied water but a higher one in the filter effluent. The phenomenon mentioned by Smith[1] at Richmond, Va., wherein chloramines freed the accumulated organic matter from the filters, has been repeatedly noticed at Orange. When algae which are normally retained in the filters are attacked by chloramines, the taste and odor producing oils contained therein seem to be liberated. These oils then pass through the filters either as a solution or emulsion. A diminution of the ammonia at such times is usually helpful in correcting the condition. This checks precisely the observations of Smith. It must not be inferred that all algae tastes can be overcome by this method. A recent growth of less than 200 standard units of Anabaena per c.c. would not yield to such treatment and a few complaints ensued. The difficulty was only overcome by cutting off the upper impounding reservoir, in which the growth occurred, for the time being until a treatment of copper sulphate had destroyed the growth.

One totally unforeseen difficulty arose. In a spirit of optimism, during the latter part of the summer of 1932, the residual chlorine in the water at the consumers' faucets was permitted to rise to a point beyond that ever reached before with chlorine alone. Two complaints were received from dead end districts and samples taken at that time revealed a strong odor similar to iodoform whereas the taste, although noticeable, was not particularly objectionable. It is believed that this was due to a breaking down of some of the pipe coating in the presence of a stronger quantity of oxidizing agents than had ever occurred before. This condition has been observed elsewhere in dead ends, particularly by Bakke,[2] but as far as can be found at this writing no case has been reported where tastes and odors of this type could be attributed to an increase in residual carried in the mains as a result of ammoniation.

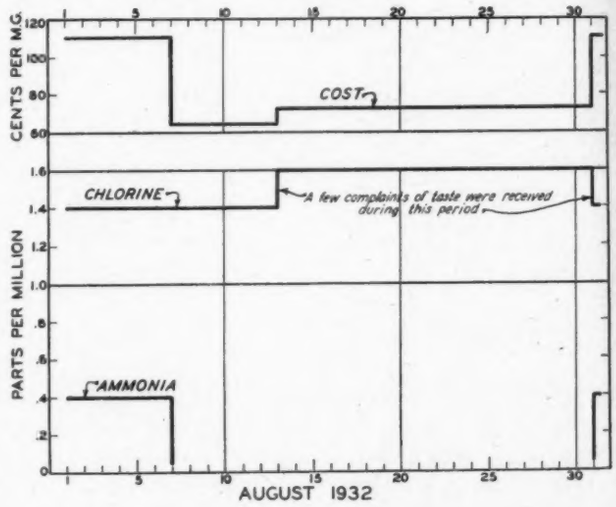


Fig. 3

Other pertinent facts that may be helpful in comparing these experiences with those elsewhere are:

(a) The pH of raw water 6.5 to 7.8; treated water 7.1 to 8.5

(b) Ratio of chlorine to ammonia varied from 2 to 1 up to 5 to 1; average 3 to 1.

Cost of Sterilizing Agents

The table of costs shows clearly the consistently greater costs during the second half of the year. Also, during the first six months the increase in cost due to the use of ammonia is less than in the second half. In fact the first half of 1932, with ammonia in use, showed a lower cost than the first half of 1931. However, this was due to abnormal conditions in the first half of 1931 and would not ordinarily hold true.

Year	Cost per M.G. 1st 6 mo.	2nd 6 mo.	Year	Remarks
1929.....	$0.38	$0.59	$0.48	Filters started in July
1930.....	.31	.58	.45	
1931.....	.45	.70	.57	
1932.....	.43*	.86	.65	Ammonia started in January
1933.....	.54			

*Omitting first part of January when initial tests were conducted with chloramines.

During the years 1929, 1930 and 1931, the average

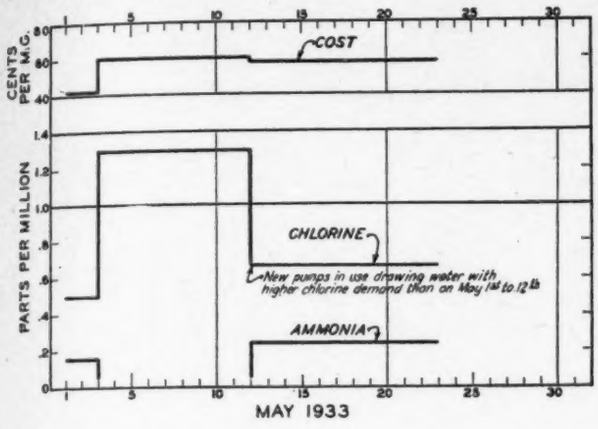


Fig. 4

chlorine dose was 1.09 parts per million while for the year 1932, with ammonia being used the average chlorine dose was only 0.82 parts per million. The rate for 1933 will probably be about 0.95 p.p.m.

General Observations

The lag or delay in sterilizing action with chloramines which has been commented on by many writers, has been repeatedly observed in the case at hand. It has also been noticed that better results have been obtained at low pH values. This conforms to the laws set down by Enslow.[3]

Many instances of high residuals permissible at consumers taps (up to nearly 1 p.p.m.) have been reported elsewhere when using the ammonia chlorine process. The writer had occasion a few months ago to recommend the installation of an ammoniator for a surface supply of nearly the same size as that herein described, with nothing but sedimentation in a storage reservoir being depended on for clarification. Formerly residuals of 0.1 to 0.2 p.p.m. were considered normal at the first service tap, about one mile below the storage reservoir, but, with chloramines, residuals of nearly 1 p.p.m. have been possible without causing complaints.

At Orange, following the introduction of ammonia, the residual at the consumers taps has only been raised slightly while that of the filtered water at the plant has, on account of a low assimilation point, been retained at approximately the same level as before. Apparently chloramines do not materially increase the assimilation point of a soft filtered water but the sterilizing action becomes more attenuated. It is important to note, however, that the chlorine dose has been reduced on every occasion when ammonia has been introduced and increased after the ammonia has been shut off (see Figs. 2, 3 and 4). With the same chlorine dose the residual in the filtered water would be materially greater with ammonia than without.

1. Chlorinous tastes are likely to occur in any chlorinated water supply, particularly when the critical temperature is reached.

2. The prevention of such tastes is more difficult in filtered than non-filtered water.

3. The use of ammonia is very helpful in preventing chlorine tastes and many foreign tastes created by chlorination.

4. Algae tastes may be accentuated by chloramines if an average ammonia dose is used. Better results than with chlorine alone, however, can often be obtained by reducing the ammonia rate somewhat.

5. Pipe coating decomposition, with subsequent iodoform tastes, may be experienced in dead ends if the use of chloramines is too liberal.

6. The total cost of sterilizing agents can often be reduced during cold weather when ammonia is used but the yearly average cost will usually be greater than with chlorine alone.

7. The additional cost of ammonia is generally well justified.

In general it appears that chloramines are destined to reach a much higher place in the esteem of water works men. The use of ammonia seems to have been successful in the majority of cases where the objective has been the prevention of ordinary chlorine or chlorinous tastes. Many of the failures seem to have been due to attempts to use chloramines for the prevention of some unusual taste. The habit of expecting too much of the process has prevented a true evaluation of its merits. It is the belief of this writer that in time to come, it will not be a question of whether or not a chlorinated supply requires ammonia but rather where to inject the latter, what ratio to use, and during what seasons of the year.

The Orange plant has been under the direction of City Commissioner George Roach for a number of years. The filters and new pumping stations were designed by Runyon and Carey, Consulting Engineers of Newark, N. J. James E. Williamson, Engineer and Contractor, installed the filters and equipment. The plant has been

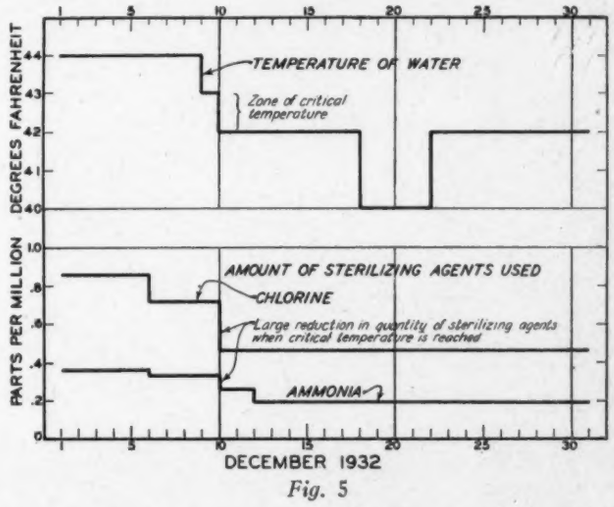


Fig. 5

under the direct supervision of Mr. Fred Luthy as Chief Engineer, and the writer has served in an advisory capacity on water treatment.

References

1. Smith: 80-157. Water Works and Sewerage (May 1933).

2. Bakke: 16-730. Jour. A.W.W.A. (Dec. 1926).

3. Enslow: 78-55. Water Works and Sewerage (March 1931).

Other recent contributions of importance are:

Orchard: 25-390. Jour. A.W.W.A. (March 1933).

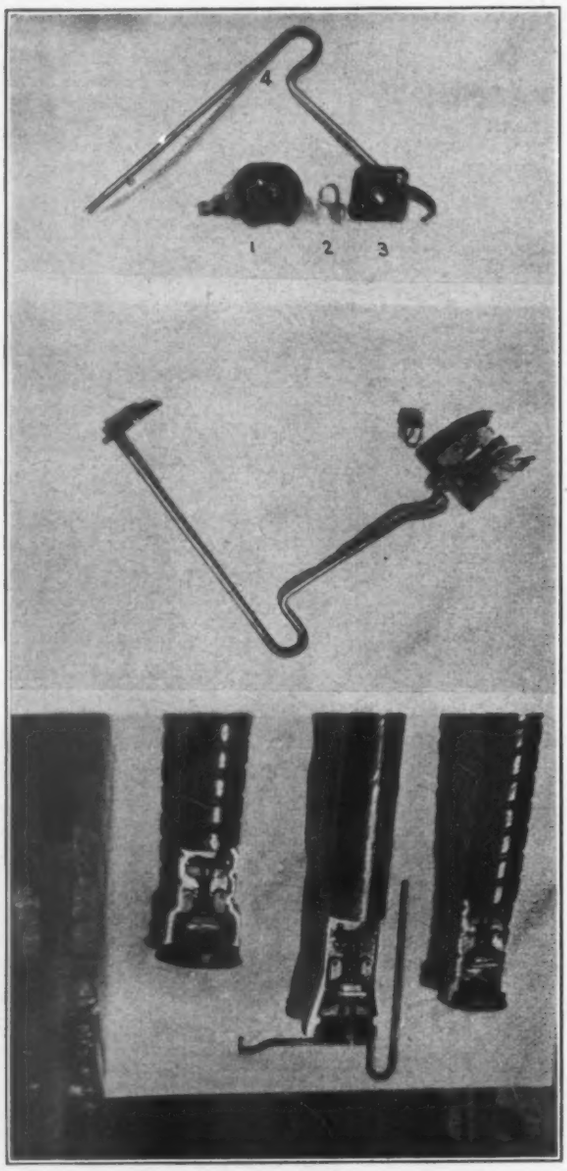
Adams and Buswell: 25-1119. Jour. A.W.W.A. (Aug. 1933).

"A Handbook of the Ammonia Chlorine Process," by Wallace and Tiernan, Newark, N. J. [A comprehensive publication carrying a valuable bibliography.]

A LOCKING DEVICE FOR CURB BOXES

By E. T. CRANCH
Manager-Superintendent, New Rochelle Water Co., New Rochelle, N. Y.

MANY water works managers are troubled with the illegal use of the connection in the curb box. Sometimes plumbers take it upon themselves to open a connection at the curb and then neglect to notify the water works office that this has been done. A tenant may move out of a house and notify the water works office to close the account and as a consequence the water is shut off at the curb. Then the owner will lease the house to a new tenant and the owner will take it upon himself to turn the water on at the curb and fail to notify the water works office that he has done so. Last but not least, in the control of delinquent accounts it all too often happens that after water has been shut off for non-payment of bill the occupant of the premises will promptly turn it on again as soon as the turnkey has left.



Locking Device for Curb Boxes

The New Rochelle Water Company has given considerable thought to developing a method of preventing these abuses. It was faced with the necessity of devising a locking device which could be inserted within the curb box and locked securely, but at the same time would not interfere with the cover of the box and would be adaptable enough to fit several types of boxes.

Each of the three types of boxes in common use on the system was studied and in the beginning a separate device was made up for each type of box, but these lacked the advantage of being interchangeable. Finally, in cooperation with the Engineering Department of Mueller Company, an adaptation of the Mueller Repair Lid was developed. This device (illustrated) fulfills all the requirements and will fit any of the three types of curb boxes in use.

Plate I (the upper picture) shows the component parts of the locking device. "1" is the expanding section which grips the sides of the curb box, "2" is the padlock, "3" is a plate which fits into the recesses of the expanding section and prevents the screw in the center from being turned after the padlock is inserted, "4" is the wrench used for inserting or removing the device.

Plate II (center picture) shows the manner in which the special wrench is used.

Plate III (lower picture) shows three different types of curb boxes with sections cut away exposing the complete unit in place.

While a relatively light padlock is used it is believed that any one who will break this lock would not be stopped with a heavier lock. Also, even though the lock is broken, it requires considerable trouble to remove the device without the proper wrench.

Of the two hundred of these locking devices that have so far been put into service by our company, there has been only one instance where someone has broken the lock and one instance where the whole top section of the curb box was demolished. With these two exceptions, this method of controlling the use of curb boxes has been most successful.

▼

Stopping Water Waste Furnishes Work for C.W.A.

The Federal Civil Works Administration, late in November approved projects of the City of Chicago that put nearly 10,000 men at work on the rehabilitation of the distribution system of the city water works. This work included the stoppage of leakage, and this with other contemplated repairs and adjustment, will, it is estimated reduce the pumpage by 200,000,000 million gallons a day during seven months in the year and greatly improve the service, during the five other summer months. The city now pumps 1,000,000,000 gallons a day.

The importance of stopping leakage is shown by the case of Joliet, Ill. In 1931 this city was pumping approximately 7,500,000 gallons per 24 hours. As a result of locating leaks in the system this pumpage was cut down to approximately 3,000,000 gallons per day and the power cost was cut about 50 per cent.

EDITORIALS

Going Forward

PRESIDENT ROOSEVELT in addressing the joint session of the House and Senate on January second, drove home the statement—

"We have undertaken new methods. It is our task to perfect, to improve and to alter when necessary, but in all cases to go forward."

Two days later the President presented to Congress a plan entailing government expenditures of something better than $10,000,000,000 for the present year and about $8,600,000,000 during 1935. Of these amounts, under the heading of "Emergency," was listed for public works, $1,677,190,800 during 1934 and $1,089,883,100 during 1935. "Additional" appropriations, constituting a part of the annual totals above, amounting to $1,166,000,000 for 1934 and $2,000,000,000 for 1935, which the President requested at the last minute for recovery needs not at present stipulated, have not been ear-marked in the budget.

Such proposed expenditures seemed staggering to Congress, and probably to the country at large, when it was realized that the total public debt under the plan would be increased by six billion odd dollars to $28,679,969,728 at the end of the next fiscal year—June 30, 1934—and approximately the same at the end of the following year. The highest previous public debt in the history of the country was the World War debt of $25,485,000,000 in August, 1919, whereas the post-war low was $16,185,310,000 in 1930.

If, however, comparison is made with the debt burden of the central government of Great Britain of some $38,500,000,000 at present rates of exchange [amounting to about $940 per capita], the proposed Federal debt of 28.7 billion dollars—[about $225 per capita, which will be reduced to $134 upon return of the 64 cent dollar to the old standard value]—loses considerable of what appears, on first sight, to be a staggering if not dangerous load on the nation.

Only, if this country should be considered less wealthy than Great Britain—and that is hardly possible—can we feel that the increased indebtedness, proposed by the President and the U. S. Treasury Department as an emergency measure, is to become unsupportable or intolerable. If Great Britain has borne up under its load for the considerable period that it has, certainly the United States can stand on its feet for a relatively brief period during which recovery can be decisively and permanently established. If the World War debt did not bankrupt the country nor upset us mentally, then our "Economic War" debt should do so neither; because, it has justification far beyond that brought on by purchase of equipment for *destruction*. This new debt is to pay the cost of *construction* of lasting value—the aftermath of a different sort of war.

The impetus gained in applications for PWA and CWWA assistance for municipal projects toward the close of 1933 has probably encouraged the President in his recovery program to an extent that he has asked Congress at the last minute to appropriate the extra amounts, averaging better than $1,500,000,000 for the two years—1934 and 1935—which he asks to have made available upon demand for needs at present unseen.

The better feeling over the country at large has caused municipal authorities to proceed with refinancing or other steps which will enable the city or town to benefit by PWA loans or grants for desirable public works. Numerous cities have awakened to this opportunity to clean up their "back-yards" to satisfy state authorities, or riparian owners, and to produce employment by constructing new, or improving existing sewerage systems and treatment works. Evidence of this is found in the fact that of the non-federal public works projects approved, to date, 21 per cent have been for sewerage and only 12 per cent for water works.

If the tax-paying population of this country are awake to the opportunity it has (as never before and probably never to come again in their natural lifetime), to procure sanitation improvements of a lasting nature, the President will find good need for the additional appropriation he has asked for. It is not improper to ask why this country should tolerate the continued pollution of streams to the extent that recreational values of the waters are destroyed—not to mention the more important increasing burdens on water purification processes. Why should authorities be willing to admit the necessity of continuing to allow Class "C" streams to remain longer as such? Class "C" streams are "abandoned streams"—those which are forever consigned as essentially open sewers.

The present opportunity of stream reclamation in America is an important one but there is more to be done than mere treatment of domestic sewage. Industrial wastes are in the aggregate a more important element in stream loading or as burdens on municipal sewage treatment works than is the domestic contribution. Consideration of this phase of stream improvement—i.e., reduction of industrial pollution—needs attention hand in hand with municipal endeavor. Federal funds are available for use in evolving measures for remedying industrial pollution—to wit, the allotment of Civil Works funds to professional use. An example of this is found at Madison, Wis., where the problem of packing plant waste treatment is being investigated by chemists and engineers employed with CWA funds. Similar cases are found in recent additions to staffs of state organizations charged with stream pollution matters, such being the case in Virginia and in other states.

The immediate future presents an opportunity to reclaim our national self-respect by providing municipal and industrial sewage treatment facilities which, if followed through vigorously, will mark the beginning of an era of stream cleansing that sanitarians have prayed for these many years—even in the face of a general public indifference. Industry must take a hand: If not willingly, the molding of public opinion, started in this period of development of stream cleansing conscientiousness, will result in forceful and probably uneconomic measures later.

In the President's language—"it is our task to perfect, to improve . . . in all cases to go forward." This is the opportunity of opportunities. The door to a golden era of stream cleansing is opening in this country and the funds are to be made available to put into effect the nation-wide improvement, if we will. Water works men should not be less concerned about this matter than are sanitarians generally. What is one community's sewage is frequently the other's water, so it's a case of "one for all and all for one." Can we put it over?

A REVIEW OF TRADE LITERATURE

More frequently than otherwise, bulletins and booklets prepared for distribution by manufacturers, contain information and technical data not readily available elsewhere. Such literature in many instances contains the most valuable up-to-the-minute information procurable and therefore the publishers of WATER WORKS AND SEWERAGE consider it worth while to devote a fair amount of space to reviews of trade literature published by manufacturers—particularly so in this first issue of the New Year, when there is an enlivened interest in improved equipment and processes and in new construction.—THE EDITOR.

Tests of Paints for Water Tanks

An informative and useful report covering exhaustive and practical large scale tests of the durability of almost 200 different kinds of paints and other coating materials, offered for use on interiors of steel

Technical Bulletin No. 3304

water tanks, has been reprinted and distributed by Pittsburgh-Des Moines Steel Company of Pittsburgh, Pa.

The tests covered 1 year and 10 months of exposure to the highly corrosive water of Ambridge, Pa., in a million-gallon steel tank—all materials involved being subjected to identical conditions of submersion and exposure by vertical strip-painting the side walls of the tank. Many of the paints, commonly used for protection of interiors of tanks, had a life of but a few months in contact with the Ambridge water.

From the results of these tests, involving 196 coatings and observations covering a period of 571 days of exposure, certain definite conclusions are put forth in the report. A table is printed which gives the paints and coatings used a per cent rating, (a); in the order of their durability and relative cost per gallon and per unit area of coverage, (b); by name of product and producer. The approximate composition of each is also stated and reproduced photographs show the appearance of the test strips at the completion of the test.

Technical Bulletin No. 3304 is the most useful reprint of its kind yet distributed—it tells both "names and tales." By all means request a copy for your files. Address Pittsburgh-Des Moines Steel Company, Neville Island, Pittsburgh, Pa., or WATER WORKS AND SEWERAGE, 420 Lexington Ave., New York City.

"NO-OX-ID" for Rust Prevention

The Dearborn Chemical Company of Chicago have recently issued a booklet setting forth results from the application of "NO-OX-ID" to metallic equipment and surface for prevention of corrosion. An interesting use of this rust preventative has been its application to corrodable equipment and mechanisms such as aeroplane parts, etc., taken on the first, and the present, expedition to the Anartic by Admiral Byrd. "NO-OX-ID" has also proven its merit in the railway field where corrosion from moist air and sulphur fumes is severe. In pipe line protection it has been successfully used where water and soil corrosion conditions have proven severe.

"NO-OX-ID" is a chemically compounded rust preventative which comes in consistency for use in dipping vats, hand brushing or hand spraying treatments. "NO-OX-ID" Fillers are used for the protection of interior steel surfaces and as paint primers for exterior treatments. As explained in their new booklet, "Proof of Results with NO-OX-ID," there is a "NO-OX-ID" treatment for every need.

For this booklet address Dearborn Chemical Company, Straus Building, Chicago, Ill.

New Booklet on Taste and Odor Control

Industrial Chemical Sales Company of New York City has just issued a new booklet on "Taste and Odor Control."

It contains "up to the minute" information on the "why and how" of taste and odor control with Aqua Nuchar—the pioneer water purification powdered activated carbon. Every worthwhile bit of information and modern practice in the application of powdered carbon to water is discussed. In the appendix appears specific "Suggestions for Taste and Odor Control"; procedures for making "Routine Taste and Odor Determinations"; a helpful method of "Coagulation Control," and three useful tables complete the booklet. It was prepared for limited distribution by F. E. Stuart, the company's specialist in water treatment. Copies are available as long as the supply holds out. Address Industrial Chemical Sales Company, 230 Park Ave., New York City.

International Filter Company Leaflet No. 5004

International Filter Co. of Chicago has recently issued a novel leaflet of four pages which tells a complete picturized story of how and where each of 16 pieces of International equipment fits into the modern water purification plant. New among the group is the Infilco "Supermix" mechanical coagulator with spiral flow induced by ingenious agitators. Leaflet 5004 is worth asking for, if you haven't seen it already. Address International Filter Co., 59 E. Van Buren St., Chicago.

"A. A. A." Protective Coatings

Quigley's "Triple A" protective coatings have been used for efficient protection of metallic and masonry structures against corrosion in the industrial and water works fields for a number of years. In recent years "Triple A" products have been used effectively on sewer systems, at sewage treatment plants and pumping stations to ward off the attack of metal parts by destructive hydrogen sulphide and chlorine gases. For distinctive painting of various pipe lines there are many colors available, including an aluminum paint with black "Triple A" base, all having a high luster on drying. "Triple A" coatings are resistant to alkali and acid alike, possess a high power of penetration and retain their elasticity. Their booklet, "Preventing Corrosion with A. A. A. Coatings," is worth requesting. Address Quigley Company, Inc., 56 W. 45th St., New York City.

Hungerford Air-Water-Wash System

Hungerford & Terry, Inc., Clayton, N. J., have issued Bulletin 23 which discusses the theory and practice of filter washing. From years of experience the organization of Hungerford & Terry believes an "air-water-wash" system to be the most economical and effective means of keeping filter beds in first-class operating condition. As a consequence, they present arguments in support of these claims and describe the system and equipment which the company has recently developed.

Bulletin 23 will interest every waterworks man. It may be obtained gratis by addressing Hungerford & Terry, Inc., Clayton, N. J.

Chemical-Mechanical Treatment of Sewage

(*Laughlin Process*)

A recent brochure distributed by Filtration Equipment Corporation of New York City, depicts the "Treatment of Sewage by the Laughlin Process" and lists results and advantages therefrom, with data procured from long-period operation of the Dearborn sewage treatment works. The brochure also announces that the American Cyanamid Company has taken over the Filtration Equipment Corporation* which owns the Laughlin process and apparatus for treatment of domestic and industrial sewages and that the experience and personnel of the latter are at the service of consulting and city engineers. The closing paragraph states that the chemical-mechanical Laughlin process is not put forth as a "cure-all" in the sewage treatment field, but where it does fit it should show favorable results, technically and economically. Copies of this brochure may be had by addressing Filtration Equipment Corporation, 350 Madison Ave., New York City.

*The new corporation will operate as a separate division of the parent company to promote the Laughlin process with W. C. Laughlin, S. T. Featherstone and J. W. Boyer serving as active vice-presidents.

Graver Corporation Issues Attractive New Bulletins

Three new bulletins have just been issued by the Graver Tank & Manufacturing Corporation, 322 S. Michigan Ave., Chicago, Ill.

"Graver Water Filters" describes and thoroughly illustrates Graver pressure type filters, automatic coagulant feed, pH adjustment control units, proportioner chemical feeder, iron removal by the "Ferrex" Zeolite process and taste and odor removal by special granular activited carbon said to have structural strength and long life.

"Swimming Pool Water" describes the complete line of Graver equipment supplied for high efficiency pool water purification, sterilization and care of the pool proper.

"Graver Elevated Steel Tanks" contains pictures of typical Graver tanks, including the Allen Hazen memorial tank of classic architectural simplicity at Des Moines, Ia.

All three bulletins do credit to Graver equipment and are at once utilitarian and attractive, with particularly pleasing illustrative matter.

The Technical Story of Toncan Pipe

"The Technical Story of Toncan Iron Pipe" is told in a booklet of the same title recently published by the Republic Steel Corporation of Youngstown, O. Of special interest to engineers, chemists and managers of water works and sewerage, this booklet sets forth facts and technical data pertaining to the performance and durability of corrosion-resisting Toncan iron pipe. Informative statements appear, covering the properties of the alloyed copper-molybdenum-iron product—Toncan Iron—and its advantages as a material for pipe which is produced as an all electric welded product. Discussions of how rust is produced; resistance to corrosion; physical properties; welding and fabrication and vibration resistance of Toncan pipe, and where it may be profitably used, appear in this educational booklet of 24 pages, devoted to technical discussions rather than sales talk.

Ask for Form ADV. 222-B. Address Republic Steel Corporation, Youngstown, Ohio.

New Morris Pump Bulletin

A new bulletin on side suction volute pumps has been recently published by Morris Machine Works, who orginated this type of pump and have been developing its design and extending its applications for almost 70 years.

Bulletin 149 describes the recent improvements in the construction of Morris pumps of both horizontal and vertical designs. The typical performance curves show a non-overloading power characteristic and high efficiency over a wide range of capacity.

Morris side suction pumps are built in sizes from 1 to 20 in. for capacities up to 14,000 g.p.m. at heads up to 120 ft.

Copies of this new bulletin, of special interest to engineers and contractors, may be obtained by addressing Morris Machine Works, Baldwinsville, N. Y. Ask for Bulletin 19.

The "Cement Gun" and "Gunite"

The Cement Gun Company of Allentown, Pa., manufacturers of the "cement gun," have issued a new and elaborate booklet which describes improved equipment for applying "Gunite." It sets forth (illustrated) the many uses of "Gunite" in repairing concrete and masonry structures and for economical construction of new water works and sewerage structures, including dams, reservoirs, water tanks, steel pipe protection, conduit and tunnel lining, the encasement of columns and girders, etc. One very useful section of the booklet is devoted to specifications for the composition of "Gunite" for numerous and varied uses. The latest control device, the "nozzle velocity meter," for improved "cement gun" operation and more uniform "Gunite" production, is illustrated and described.

Write the Cement Gun Comany, Allentown, Pa., for Bulletin 200, descriptive of modern "Guniting."

Screw Feed Sludge Pump and Sludge Flow Regulator

The Chicago Pump Co. of Chicago have recently issued a new booklet which describes and illustrates their interesting screw feed centrifugal type pump, for handling sewage sludges, and a more recent addition—the sludge flow regulator. The latter is designed to set a telescopic tube at any desired elevation of overflow and thereby regulate rates of sludge delivery from a tank, sludge depth maintained in tanks and, thereby, sludge densities. It can be used in conjunction with sludge pumps or gravity discharge of sludge to digesters or dewatering filters. Write for Bulletin 128-D1. Address Chicago Pump Company, 2336 Wolfram St., Chicago, Ill.

Centrifugal Pumps After 20 Years of Progress

In recent years the efficiencies of centrifugal pumps used in water works practice have been greatly improved, as have the efficiencies of the driving motors. By 1928 the output of centrifugal pumps, per unit of power, has been increased to almost double the record performances of this type of pump in its highest stage of development in 1913.

A. Peterson, chief engineer of the pump department of the DeLaval Steam Turbine Company, Trenton, N. J., recounted developments which have taken place in this field during the past twenty years in a paper presented before the American Water Works Association at its 1933 annual convention. It is evident that the context of the paper, and proven in practice also, that many pump installations now in service could be scrapped and replaced by modern units with profit to the purchaser.

Mr. Peterson's paper has been reprinted for distribution by the DeLaval Company, copies being available to anyone requesting them.

New Pump Bulletin Issued by Nash

Twenty years ago the Nash Engineering Company introduced the now famous "Hytor" air compressors and vacuum pumps. From time to time new equipment has been added to the Nash line but for the first time all of the pumping equipment manufactured by this company has been included in a single compact booklet of 35 pages. In addition to Nash pumps, the Jennings sump and sewage pumps, Jennings (no valve) pneumatic sewage ejectors and Jennings self-priming centrifugal pumps are described. The several entirely new developments shown include staged Nash compressors and vacuum pumps.

This compact bulletin (No. 217) can be secured by addressing the Nash Engineering Company, South Norwalk, Conn.

EVERY WATER WORKS OPERATOR SHOULD HAVE . . . .

Water Purification Control

By EDWARD S. HOPKINS

Principal Sanitary Chemist, Bureau of Water Supply, Baltimore, Md.

I COAGULATION
Time of Mixing, Floc Characteristics, pH Control, Color Removal, Iron and Lime Coagulation, Use of Sodium Aluminate, Manganese, Coagulation Control.

II SEDIMENTATION
Effect of Settling on Plant Control, Cross-Baffled Basins.

III FILTRATION
Filter Beds, Rate Controllers, Filter Washing, Care of Filter Beds, Mud Deposit Formation, Sand Grading, Air Binding, Sand Cleaning, Filter Control Records.

IV DISINFECTION
Chlorination, Ultra Violet Ray and Ozone Treatment.

V TASTES AND ODORS
Superchlorination, Chloramines, Activated Carbon, Aeration, Permanganate, Algae Control.

VI CORRECTIVE TREATMENT
pH Control, Effect of Corrective Treatment.

VII PLANT CONTROL DATA
Standards of Purity.

$1.75
POST PAID

For many years there has been a real need for a short, non-technical, informative, practical handbook for the plant operator. **Water Purification Control** is particularly designed to meet this need and presents many usable facts in a simple and systematic form. A glance through the table of contents will readily reveal the wide scope and practical value of the book to the plant operator who is interested in improving the efficiency of his operations.

This book is **practical.** It gives the most up-to-date methods in the simplest possible way. It is addressed particularly to the operator who has charge of a small plant and must "go it alone." Here is a miniature encyclopedia, including a manual of directions on equipment and construction. Many useful tables are included and the book is fully illustrated.

We invite your examination of this practical workbook at our expense. Mail the attached coupon today!

10 DAYS' FREE EXAMINATION

WATER WORKS AND SEWERAGE
400 W. Madison St., Chicago, Ill.

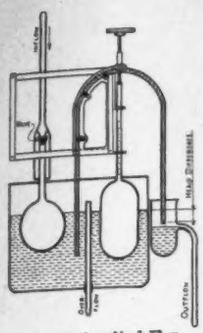
Gentlemen:

Please mail me a copy of WATER PURIFICATION CONTROL. In 10 days I agree to return the book or remit $1.75 in full payment.

NAME .....

POSITION .....

ADDRESS 1-34



Patent Applied For

Will Feed the Most Corrosive Chemicals

The Phipps & Bird Solution Feeder provides the ideal answer to the demand for a solution feeding apparatus with an accurate and constant feed, that is not effected by corrosive substances, that is easy to install and simple to operate, and that is economical both in initial and operating costs.

Let us send you detailed information regarding this new feeder. Whether your plant is large or small or only for experimental purposes, you will find it a most efficient apparatus for your requirements.

PHIPPS & BIRD, Inc.

915 East Cary Street
RICHMOND, VIRGINIA

SIMPLEX

Simplex Indicating Recording Totalizing Meter Register

Venturi Type Meters
Effluent Controllers
Filtration Plant Gauges
Water Works Specialties

WRITE FOR BULLETINS

SIMPLEX VALVE & METER CO.

6743 Upland Street
Philadelphia, Pa.

17 YEARS

ON THE PACIFIC COAST SERVING WATER AND SEWAGE PLANTS

For 17 years Bear Brand chemicals have been serving in municipal and industrial sanitation and Great Western engineers have been on the job helping to solve water purification and sewage problems on the Pacific Coast.

If your problem is a comparatively simple one of sterilizing and disinfecting, specify . . .

BEAR BRAND Liquid Chlorine

If objectionable taste and odor must be eliminated and higher residual chlorine is desired with ammonia-chlorine treatment, specify . . .

BEAR BRAND Ammonia

For chemical treatment of sewage or more efficient and economical coagulation in your water purification plant, use . . .

BEAR BRAND Ferric Chloride

Warehouse stocks of Bear Brand chemicals are kept in convenient centers. Our plant at Pittsburg, Cal., assures practically our entire trade area of overnight service on an unlimited reserve of chemicals you may need urgently.

If it's a water purification or sewage treatment problem, consult

Great Western Electro-Chemical Co.

9 Main Street, San Francisco
Plant: Pittsburg, California
4151 Bandini Blvd., Los Angeles

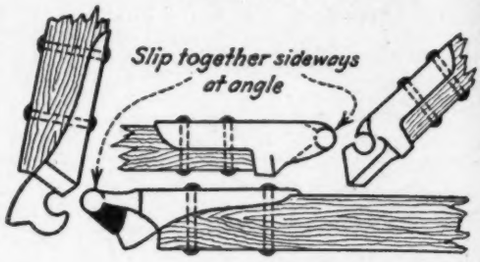
Use **LAMOTTE EQUIPMENT** *for*
pH Control—Residual Chlorine Control
Boiler Feed Water Control
LAMOTTE CHEMICAL PRODUCTS CO.
442 Light Street, Baltimore, Md.

Complete Equipment For
WATER PURIFICATION AND SEWAGE DISPOSAL PLANTS
Dry Chemical Feeders
E. W. BACHARACH & CO.
Rialto Building Kansas City, Mo.

EDSON'S NEW HAND PUMP
Smallest Diaphram Pump Made. 2" Suction Open Discharge. Capacity 1400 G.P.H. Weight 50 lbs.
THE EDSON CORP'N, 49 "D" Street
So. Boston, Mass.
NEW YORK: 142 Ashland Pl., Brooklyn
CHICAGO: 3500 N. Long Ave.
Catalog "T" Gives Full Data, Also Edson Hand and Power Pumps, Suction Hose and Pump Accessories

Filtration **Oil Bound Water Paint**
SAND--LINDEX
Specification Grade **Bulk or Bags**
—Powder Form—
One coat covers Black. Not affected by fumes of Sulphur, Lime, Chlorine.
Mines and Mills: Ottawa, Illinois
TAMMS SILICA CO. 228 N. La Salle St., Chicago
Chicago

STEWART SEWER CLEANING MACHINE
Water Cleaning System, if you wish it, or Drag Bucket type.
WE WILL PAY FREIGHT AND CHARGE TO BILL.
We Ship Rods for Trial—who else will do this?
We also make a Rod that will float. Also rods with wheels for conduit work.



SEWER AND CONDUIT RODS
No Deep Shoulder Cut for Couplings. Rods retain full size and strength.
Investigate our JUMBO ROD

W. H. STEWART
1614 Locust Street . . . . . ST. LOUIS, MO.
129 George Street . . . . . BOSTON, MASS.
Box 581 . . . . . JACKSONVILLE, FLA.
CANADA FACTORY, WALKERVILLE, ONT.
Therefore No Duty for Purchaser to Pay
PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO

WHEN YOU NEED IT MOST.. **A handy, compact source of reference for practically all engineering problems in the field or at the office.**

The Engineer's Vest Pocket Book
By W. A. Thomas, Consulting Engineer

The scope of this book is almost incredible. Regardless of the branch of engineering you follow, you will find it an invaluable source of reference, and its clear, compact arrangement will win your instant approval.

Formulas are given which meet nearly every kind of engineering problem, and the generous tables and diagrams are helpful in providing short cuts.

See it for yourself and judge its value to you. Send no money. Just fill in the coupon.

GILLETTE PUBLISHING CO.
400 W. Madison St. Chicago, Ill.

12 MAIN DIVISIONS
Mathematics, Statics and Dynamics, Strength of Materials, Bldg. Construction, Mechanical Design, Heat, Hydraulics, Chemistry and Physics, Electrics, Transportation, Surveying, Costs and General Classified Directory.

Gillette Pub. Co., 400 W. Madison St., Chicago.
Please send "The Engineer's Vest Pocket Book" for me to examine. If it is satisfactory, I will remit $3.00; otherwise I will return the book within 5 days.
Name .....
Position .....
Company .....
Address .....
City ..... State ..... WW&S-1-34

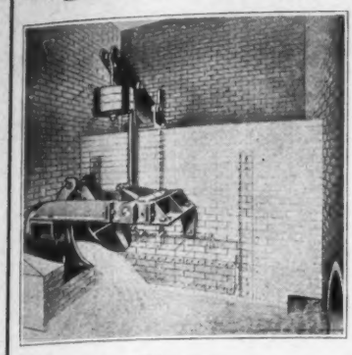
HERE one finds a friendly hospitality grown out of three generations of service to socially and commercially alert Philadelphians and to distinguished visitors from all parts of the world.

Here, too, every modern idea that could add to the comfort and pleasure of our guests. . . . The Bellevue is convenient to railway terminals, clubs, banks, retail stores and important office buildings.

Rates consistent with today's budgets

BELLEVUE STRATFORD
PHILADELPHIA
CLAUDE H. BENNETT, *General Manager*

Dependable Control Guaranteed
with the
McNULTY
TOGGLE - JOINT AUTOMATIC SEWER REGULATORS



TYPE "C"

Continuously automatic, there is perfect control of any predetermined flow in cubic feet per second. Being of the Flap Gate type, jamming or clogging is eliminated. Send for complete details today.

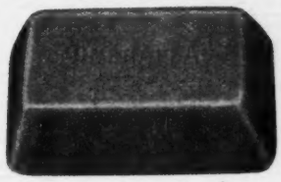
THE
McNULTY
ENGINEERING CO.
200 Old Colony Ave.
So. Boston, Massachusetts

GRAVER
WATER TREATING AND STORAGE

Elevated tower tanks and tanks on concrete bases. Special fabrication of steel and alloy plate. Reliable consulting and designing engineering service. Write for bulletins.

GRAVER TANK & MFG. CORP.
General Sales Office 332 South Michigan Avenue, Chicago
General Offices and Factory East Chicago, Indiana
Representatives in Principal Cities

THE NATIONAL METHOD
of Water Main Cleaning
20 Years Experience
Write for Booklet
"The Cleaning of Water Mains"
National Water Main Cleaning Co.
32 Church St. New York



USE MINERALEAD
For Jointing Bell and Spigot Water Mains

Easy handling, ingot form—Impervious to moisture—Absolute uniformity—Easy melting—Rapid pouring—No caulking—Less initial leakage—Bell holes unnecessary—A saving in cost of material and labor.

Write for Catalog
THE ATLAS MINERAL PRODUCTS COMPANY
of Pennsylvania
MERTZTOWN PENNSYLVANIA
Established 1892
G-K Sewer Joint Compound

The new **HELLIGE TURBIDIMETER**

Eliminates the preparation and use of standard suspensions—Utmost convenience—Highest accuracy. If connected to the water line, the apparatus permits a continuous check of the turbidity without the necessity of refilling tubes with individual samples.

Reads all turbidities down to zero-turbid water.

Bulletin No. 8000 contains detailed information.

HELLIGE
INCORPORATED
179 EAST 87TH STREET, NEW YORK, N.Y.

LOCAL WORK for MORE LOCAL WORKERS
LOCAL labor is not only used for the laying but also for the manufacturing of Lock Joint Pressure Pipe, thus greatly relieving the local unemployment problem.
Lock Joint Co. Est. 1905. Ampere, N. J.
LOCK JOINT REINFORCED CONCRETE PIPE
PRESSURE · SEWER · CULVERT

FILCLOR
Chlorine and Ammonia Control Apparatus
The Filelor Company
59th Street & Woodland Avenue, Philadelphia, Pa.

ROBERTS FILTER MANUFACTURING CO.
607 Columbia Ave., Darby, Penna.

Manufacturers of Pressure and Gravity Type Water Filters and Specialties for Water Purification and Sewage Treatment Plants.

We contract for complete installation of mechanical and hydraulic equipment in all forms of Water Filtration Plants, Sewage Disposal Plants and Pumping Stations.

Write us concerning your Sanitary Problems.

STREET, SEWER AND WATER CASTINGS

Made of wear-resisting chilled iron in various styles, sizes and weights.
Write for Catalog and Prices
SOUTH BEND FOUNDRY CO.
All Kinds of Gray Iron Castings SOUTH BEND, INDIANA

Yes—we would like you to mention WATER WORKS AND SEWERAGE.

ADVERTISERS IN THIS ISSUE

A

Activated Alum Corp. 8
Atlas Mineral Products Co. 51

B

Bacharach & Co., E. W. 50

D

Darley & Co., W. S. 9

E

Edson Corp. 50
Electro Bleaching Gas Co. 3

F

Filclor Co., The 51
Filtration Equipment Corp. 6

G

Gillette Publishing Co. 4-48-50
Graver Tank & Mfg. Co. 51
Great Western Electro Chem. Co. 49

H

Hellige, Inc. 51

I

Industrial Chemical Sales Co., Inc. 6
Innis, Speiden & Co. 8
International Filter Co. 8

L

LaMotte Chem. Products Co. 50
Lock Joint Pipe Co. 51

M

McNulty Engineering Co. 51
Merrimac Chemical Co. ..... Second Cover
Monsanto Chemical Co. ..... Second Cover

N

National Aluminate Corp. 7
National Water Main Cl. Co. 51

P

Pennsylvania Salt Mfg. Co. ..... Third Cover
Phipp & Bird, Inc. 49

R

Roberts Filter Mfg. Co. 51

S

Simplex Valve & Meter Co. 49
Smith Co., S. Morgan 10
South Bend Foundry Co. 51
Stewart, W. H. 50

T

Tamms Silica Co. 50

W

Wallace & Tiernan ..... Back Cover

SANITARY ENGINEER DESIGNER—Experienced on sewerage systems, sewage disposal plants and water works. Capable on hydraulic computations, structural design and municipal project layouts. Associate Member A. S. C. E. Will consider any location, either temporary or permanent. Address T. H. N., 400 W. Madison St., Chicago, Ill.

CIVIL ENGINEER—B. S. in Civil Engineering with option in Sanitary Engineering. Age 22, excellent health, and single. Best of references. Location and exact nature of work immaterial. Available now. Address J. F. T., care Water Works and Sewerage, 400 West Madison St., Chicago, Ill.

WATERWORKS SUPERINTENDENT or etc.—Fourteen years' experience with outstanding filter company. Operation, maintenance, erection. Completed many installations throughout U. S. A. Familiar with all types water purification plants and the various equipment. Desire position with municipality, contractor or manufacturer. Expert in large piping installations, handler of labor, supervision. Age 35. Married. Available immediately. Best of references. Address R. C. S., % Water Works and Sewerage, 400 W. Madison St., Chicago.

SUPERINTENDENT OF FILTRATION, Chemist and Operator. In small or medium sized plant. Industrious young man technically educated, with ten years' experience in water purification plants, last seven as superintendent of filtration and chemist. Capable of handling, maintaining and installing all types of electrical and mechanical machinery. Has own fine mechanical and electrical tools and instruments. Also some laboratory equipment. Address J. Z. C., % Water Works and Sewerage, 400 W. Madison St., Chicago.

POSITIONS WANTED

This department has been started as a service to those in the Water Works and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

SUPERINTENDENT-ENGINEER — Engineer graduate with 16 years' of practical experience in municipal engineering. For past six years in charge of water works and sewerage systems in city of importance served by filtration plant and sewage treatment works. References and qualifications gladly supplied. Location anywhere. Available for interview. Address W. T., % Water Works and Sewerage, 420 Lexington Avenue, New York City.

SANITARY ENGINEER—Young man, age 25, 3 months' experience as Topographic Draftsman. Graduate of Catholic University, Washington, D. C. B. S. in Civil Engineering. Desires position with Sanitary Engineer, Waterworks or Sewage Disposal Plant. Salary and location secondary. Available any time. Address C. F. D., care of Water Works and Sewerage, 420 Lexington Avenue, N. Y.

CHEMIST with seven years' laboratory experience, last two years in sewage treatment works, desires position as chemist in sewage works laboratory or as manager of small sewage treatment plant. A position where the quality of work, not political pull, is considered the criterion of success is desired. Address L. P. R., Water Works and Sewerage, 400 W. Madison St., Chicago.

SUPERINTENDENT—Purification and filtration, age 38; can combine operating and laboratory as chemist-operator, complete charge if necessary. Experience embraces construction, operation and maintenance of softening and filtration plants. 13 years with internationally known water purification concern. At present employed municipal plant serving three towns. Location immaterial, local or foreign. No position wanted that is influenced by political affiliation. Address W. M., % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

MECHANICAL ENGINEER—Age 26, married. Degree M. E., Syracuse University. Six years' experience drafting, computation, development. Will accept engineering position in any locality. References gladly furnished upon request. Address H. S. K., % Water Works and Sewerage, 420 Lexington Avenue, N. Y. C.

CIVIL ENGINEER, AGE 27, TWO YEARS' college, five years' experience on highway and railroad location and construction, construction of sewers and subways, inspection footing reinforced concrete and structural steel and drafting. With best references. Address P. Z., Water Works and Sewerage, 400 W. Madison St., Chicago.

SANITARY ENGINEER, 37 YEARS OF age, married, college graduate, mem. A. S. C. E. and A. W. W. A., experienced in water purification and sewage disposal, four years as sanitary engineer in foreign country. Desires position as superintendent in either water or sewage plant. Address: "J. J. M.," % Water Works and Sewage, 155 Montgomery Street, San Francisco, Calif.

CHLORINE
for
Odor Control

Modern Sewage Disposal Plant

CHEMICALS *for*
MUNICIPAL PURPOSES

Anhydrous Ammonia
Ferric Chloride • Caustic Soda
Sodium Aluminate • Chlorine
Alum • Chloride of Lime
Penchlor
(high-test Calcium Hypochlorite)

The dependable quality of Quaker Keystone Brand Chlorine is the result of more than eighty-two years' experience in making chemicals for industry.

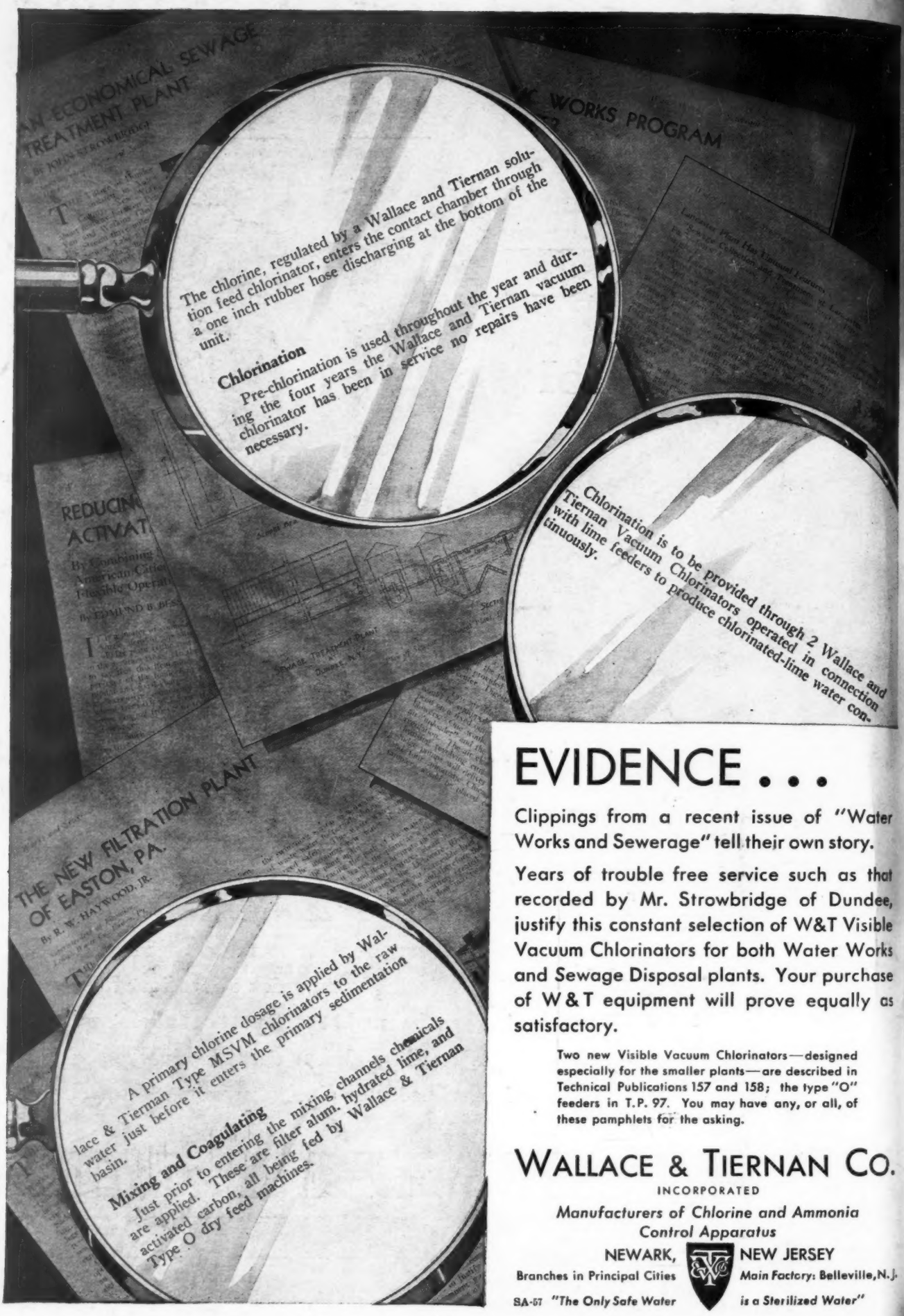
Furthermore, due to the convenient locations of our plants, quick deliveries of Chlorine can be made to all parts of the country.

We will be glad to furnish highly specialized technical advice on request without cost.

Est. 1850

PENNSYLVANIA SALT MFG. CO.

EXECUTIVE OFFICES, WIDENER BLDG., PHILADELPHIA, PA.
Branch Sales Offices: New York — Chicago — St. Louis — Pittsburgh — Tacoma — Wyandotte


AN ECONOMICAL SEWAGE TREATMENT PLANT
WORKS PROGRAM
The chlorine, regulated by a Wallace and Tiernan solution feed chlorinator, enters the contact chamber through a one inch rubber hose discharging at the bottom of the unit.
Chlorination
Pre-chlorination is used throughout the year and during the four years the Wallace and Tiernan vacuum chlorinator has been in service no repairs have been necessary.
Chlorination is to be provided through 2 Wallace and Tiernan Vacuum Chlorinators operated in connection with lime feeders to produce chlorinated-lime water continuously.
THE NEW FILTRATION PLANT OF EASTON, PA.
A primary chlorine dosage is applied by Wallace & Tiernan Type MSVM chlorinators to the raw water just before it enters the primary sedimentation basin.
Mixing and Coagulating
Just prior to entering the mixing channels chemicals are applied. These are filter alum, hydrated lime, and activated carbon, all being fed by Wallace & Tiernan Type O dry feed machines.

EVIDENCE . . .

Clippings from a recent issue of "Water Works and Sewerage" tell their own story.

Years of trouble free service such as that recorded by Mr. Strowbridge of Dundee, justify this constant selection of W&T Visible Vacuum Chlorinators for both Water Works and Sewage Disposal plants. Your purchase of W & T equipment will prove equally as satisfactory.

Two new Visible Vacuum Chlorinators—designed especially for the smaller plants—are described in Technical Publications 157 and 158; the type "O" feeders in T.P. 97. You may have any, or all, of these pamphlets for the asking.

WALLACE & TIERNAN CO.

INCORPORATED

Manufacturers of Chlorine and Ammonia Control Apparatus

NEWARK, NEW JERSEY

Branches in Principal Cities

Main Factory: Belleville, N. J.

SA-57 *"The Only Safe Water is a Sterilized Water"*